1.

HYTHE PRACTICE.

am exhibiting the results of 270 rounds, fired by 30 file, in skirmishing order, at a target representing a nine-pounder Going into battery. 120 rounds were fired at 610 yards, and 150 rounds at 810 yards; the distances in both cases being unknown to the men. (The figures on the target were of the size of life.)

The shots fired at 610 yards are thus indicated . . . . . . ●

Those at 810 yards, thus . . . . ⊗

In the first experiment there were 11, and in the second 4 hits, that could not be represented in the sketch, as they were masked.

Front.]

(See page 98.)

HAND-BOOK FOR HYTHE:

COMPRISING

A FAMILIAR EXPLANATION OF THE
LAWS OF PROJECTILES,

AND

An Introduction to the System of Musketry,

NOW ADOPTED BY ALL MILITARY POWERS.

BY

HANS BUSK, M.A., D.L.,

AUTHOR OF
"THE NAVIES OF THE WORLD," "THE RIFLE, AND HOW TO USE IT,"
"RIFLE VOLUNTEERS, AND HOW TO DRILL THEM,"
"A TABULAR ARRANGEMENT OF COMPANY DRILL," ETC. ETC.

With numerous Illustrations.

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TO

COLONEL E. C. WILFORD,

ASSISTANT-COMMANDANT AND CHIEF INSTRUCTOR, SCHOOL OF MUSKETRY, HYTHE;

WHOSE GREAT SKILL, UNTIRING ZEAL AND ENERGY

HAVE SO LARGELY CONTRIBUTED TO THE EFFICIENCY OF THAT ADMIRABLE INSTITUTION,

AND WHOSE FRIENDLY AID

HAS EVER BEEN SO COURTEOUSLY PROFFERED

IN THE VOLUNTEER CAUSE,

THIS HAND-BOOK

Is Inscribed,

IN TOKEN OF THE HIGH APPRECIATION OF HIS MOST VALUABLE SERVICES, ENTERTAINED BY

THE AUTHOR.

PREFACE.

KNOWING the strong prejudice which, sometimes, perhaps, not unreasonably, exists in the public mind against publications supposed to have an "official" origin, I take this opportunity of distinctly disavowing, on behalf of the present work, any imputation that might otherwise arise from such a suspicion.

In preparing this Hand-book for the press, I have had but two objects in view. The principal one was to give in a condensed form the information ordinarily imparted during one of the regular courses of musketry instruction at Hythe; so that those who might be fortunate enough to obtain access to that admirable institution, might not only arrive well grounded theoretically in the principles they will there find practically illustrated, but that others, who are precluded by circumstances from sharing the advantages of a month's sojourn at that training-ground, could teach themselves something more than the mere rudiments of a science which is daily increasing in national importance.

Aware of the great importance of maintaining absolute uniformity in the drill and scientific instruction of every branch of the service, I have avoided any deviation from the system laid down for the guidance of the British Army.

For the benefit of those officers who proceed to

Hythe, the authorities there have prepared a series of eight lectures, consisting for the most part of well-selected compilations, by a skilful hand, from various sources, on the subject of projectiles and of arms generally, but more particularly illustrative of the use of the rifle. In the course of the instructions here given, I have incorporated with the results of my own experience, the substance of two or three of the principal lectures above adverted to; but neither General Hay, nor his able coadjutor, Colonel Wilford, are to be held in any way responsible for the opinions expressed by me in any part of this work.

I have again, but entirely without Captain Norton's knowledge, incidentally drawn attention to the scandalous neglect with which his merits have been treated by successive administrations, and I devoutly trust that one of the few surviving heroes of Albuera, Arroyo dos Molinos, of Vittoria, of the Pyrenees, of Nivelle, of Nive, of Orthes—of almost every engagement indeed of the Peninsular War, and of not a few in India—may not descend to the grave without some tribute of the gratitude of a Nation he has served so nobly and so well.

United University Club, S.W.
19th April, 1860.

ERRATA.

Page 31, line 11, *for* Plate I. *read* Plate II.
„ 32, „ 14, } *for* Plate II. *read* Plate III.
„ 33, „ 21, }
„ 33, „ 31, }

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HAND-BOOK FOR HYTHE.

CHAPTER I.

Success of the Volunteer movement—Objects of the present work—Erroneous opinions formerly entertained on the subject of musketry—Bad practice—Its causes—Recent judicious regulations—Varieties of rifles—Difficulties of selection—Classification of rifles—Objects attained by rifling—Robins—His opinion of breech-loading rifles—American, German, Swiss, Tyrolese rifles—The "gathering twist"—Objections to it—Long and short barrels—Summary of the requisites for rifles—Jacob's rifle—Major Nuthall's—The Enfield—The Lancaster—The Whitworth.

HAVING been one of the first to advocate the formation, upon a proper basis, of a volunteer army, as the best and surest protection for this our island home, it is with feelings of peculiar satisfaction that I have viewed the gradual organization of a force, which, if properly encouraged and supported by the Government, must eventually prove the most important element of national defence that has yet been devised.

When the suggestion was originally put forth, about three years ago, it was received in many quarters with that derisive sneer with which anile fatuity is wont to greet all propositions that do not strictly accord with its own feeble views. Again and again it was asserted "that the English were not a martial race—that their aspirations did not lead them to the drill-yard, the rifle-ground, or the camp—

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that nothing could be more preposterous than to imagine the possibility of obtaining, throughout the United Kingdom, at the utmost, 5000 efficient Volunteers—that, even if a few such regiments could be formed, it would be hopeless to expect them to stand against disciplined troops," &c.

Such arguments, however, had little influence with me, and I continued perseveringly to recommend on all occasions, a movement which has already brought about far greater results than could have been anticipated in so short a period, and has more than verified the opinion I had over and again expressed of the patriotic enthusiasm of the population of this country. Now that ultimate success is all but achieved, adverse opinions are hushed; while some of those journals whose apathy or opposition were the most remarkable, not only warmly espouse the volunteer cause, but arrogate to themselves the merit of having urged the formation of the corps, already springing into existence in almost every county.

The sudden alacrity of the response made to the appeal to arm, has naturally given rise to difficulties of a temporary character. We have at this moment upwards of 70,000 young men, all anxious, as speedily as possible, to attain proficiency in their drill, together with a certain amount of skill in handling the formidable arm provided for their use. The unexpected demand for drill-serjeants and musketry instructors, cannot of course at once be met; nor is it practicable to afford, even to a tithe of our Volunteers, the benefit of a few weeks' attendance at Hythe. The object of the present treatise is to supply, in a compendious form, an intelligible analysis of the system pursued at the national school of musketry, in order that officers, whether of the line, the militia, or of volunteer regiments, may, before proceeding

thither, prepare themselves for the studies to which they will there have to devote themselves, and also, that the much more numerous class, whose avocations do not permit of their proceeding to Hythe, may be enabled, without further aid, to master the rudimentary laws of projectiles, and to apply theory to practice.

The plan of the work necessarily precludes the introduction of much original matter; the only merit to which it can lay claim, is that of conciseness, while the chief desire of the author has been to abridge as much as possible the labour of those who are desirous to perfect themselves as rifle-shots.

It was formerly supposed that a man could not acquire proficiency with the rifle, without many years' assiduous practice at a target and an enormous consumption of powder and lead. True, no doubt it is, that the greater a man's familiarity and experience with a weapon, or an instrument of any kind, the greater probability there is of his displaying skill in its use; but the method hitherto adopted, or rather the absence of any proper system, rendered an occupation irksome and repulsive that would, under proper management, have proved an agreeable pastime.

I have frequently seen soldiers, who never having had the slightest instruction in musketry, blazed away for days together, without any other apparent object than to consume so many cartridges in a given time. In one instance, some years ago, at Weedon, where a detachment of the 60th were using the two-grooved rifle, I noticed that a very large proportion of the shots, at a range of only 300 yards, struck a bank 180 to 200 feet from the target, while others flew so wide of the mark that it was impossible to say where they fell. Thinking that the rifles might be in fault, I fired a couple of rounds, and, as it happened,

hit the bull's-eye each time, the only occasions on which it was touched that day. I soon ascertained, however, that the men were really not to blame. Some of them had never previously handled a ball-cartridge, and most of them shut both eyes, and jerked upwards the muzzles of their rifles every time they pulled the trigger. On another occasion, an officer quartered in Ireland, had a large quantity of ball ammunition which he was obliged to expend somehow; by a specified time. The locality where he was stationed, offering no facilities whatever for target practice, he hit upon a very effectual expedient for disposing of his encumbrance, by sinking the cask that contained it, in a river—a proceeding for which he was, under the particular circumstances, in no respect blameable; though it can hardly be maintained that even an indefinite repetition of this operation would have been calculated to improve his men in the art of shooting.

These, however, are incidents of bygone days. Skill in musketry is now made of paramount importance in every branch of the service; and by a most judicious regulation, for which we are indebted to the present commander-in-chief, proficiency is requited by badges of distinction as well as by increased pay; so that the rank and file have a direct incentive to become marksmen. The system of instruction pursued, is simple and judicious, and its results may almost be predicated with certainty in every case.

Having elsewhere* pretty fully discussed the merits of the different varieties of rifle now in vogue, it is unnecessary to say much upon that subject here; at

* "THE RIFLE, AND HOW TO USE IT." Seventh Edition. Routledge, Farringdon-street.

the same time, I cannot imagine a much more helpless or hopeless position than that of an individual who, having determined to expend his ten or twenty guineas in the purchase of a rifle, and, guided only by the light of nature, applies to a respectable gunmaker to supply his want.

The bewilderment of a purchaser innocent of firearms must be indeed great. An artful tradesman soon perceives the perplexity of his customer, and adroitly adds to it, by placing successively in his hands two-grooved and four-grooved, elliptic-bored and polygrooved barrels, breech-loaders, and revolvers; some with an uniform "twist," others with what is called the gathering, or gaining twist; one whose grooves complete a turn in 10 feet, another in 20 inches. In short, before he has been in the shop a quarter of an hour, one can hardly be surprised if he feels ready to forswear rifles and rifle-shooting, to withdraw from the gallant corps to which he has so lately expressed an earnest wish to belong, and to doff his uniform for ever.

I never hear of an inexperienced buyer in quest of a rifle, without being forcibly reminded of the purchaser of a telescope, who, on asking the optician, among a multitude of other questions, whether he would be able to discern an object through it four miles off, received for reply, "See an object *four* miles off, sir? You can see an object four-and-twenty thousand miles off, sir!—you can see the moon, sir."

In like manner, if you naïvely inquire of a gunmaker whether a particular rifle will carry two hundred yards, the chances are he will exclaim emphatically, "Two hundred yards, sir?—it will carry fifteen hundred." And so no doubt it may; the only question is—HOW? It is not merely in the rifling, it is in the subsequent adjustment of the sights, and

in the exquisite finish of every part, that the skill of the maker is shown. There are at this moment in store, in various Government depôts, and in their present state comparatively valueless, many hundred thousand smooth-bored fire-arms. A contractor might readily be found who would convert these into serviceable rifles for a few pence each; but the subsequent "*sighting*" and regulating, would cost at least eight times as much; and, of course, the higher the quality of the arm, the greater in proportion, is the cost of finish, and of those qualities by means of which alone precision is attained.

Of the many queries propounded to me, both orally and by letter, the most frequent is—"What form of rifle do you recommend as the best?" Now it so happens that there are several distinct kinds, quite dissimilar in length, in bore, in twist, and in the form of bullet adapted for them, any of which, if properly made and skilfully used, will do nearly equal execution up to certain distances; and of these two or three that are almost on a par at extreme ranges.

Before proceeding to advert to them in detail, it may be well to observe that there are, what may be regarded, as two distinct classes of rifle. In one, the bullet, formed of the softest and purest lead, is expanded into the grooves in the barrel at the moment of the explosion; in the other, the bullet, from its form, is adapted by accurate mechanical fit to take the required revolution on its axis.

The former is commonly known as the Minié, or expanding system; in the latter, the expansion of the bullet being unnecessary, a harder material may be used. The advantage gained thereby is, that the bullet not only preserves its form during its flight, but penetrates with greater facility into any ordinary object against which it may be fired.

The question may probably, ere this, have suggested itself mentally to the reader—What is a rifle? and what is the object of rifling a barrel? This is a matter which it may, therefore, be advisable briefly to explain at once.

The barrel of the old musket, or "Brown Bess," was a tube of iron, little better than a piece of gas-pipe, plugged up at one end. The ball fitted so loosely, that if dropped down the muzzle when the barrel was clean, it would fall readily to the breech. It is obvious that, to allow of such facility in loading, the bullet must have been much smaller than the barrel, occasioning what is technically termed great "windage;" that is, space between the circumference of the bullet and the sides of the bore.

It is also equally apparent that this space caused considerable loss of propelling power from the escape of much of the explosive gas from the powder on one side or other of the ball, which might receive a direction, at the moment of its departure from the gun, entirely dependent on the side of the muzzle against which it happened last to strike as it quitted the barrel. The wild flight of a musket-ball is thus readily intelligible, for it is obvious that it might, from this cause, strike alternately a hundred feet or more to the right or to the left of the mark.

It has, besides, always been found nearly impracticable to cast a bullet which should be perfectly solid or homogeneous, a cavity or air-hole being almost invariably found in the interior. This, according to the part of the bullet where it may chance to occur, will affect the centre of gravity of the projectile, and is sufficient of itself to cause aberration or eccentricity in the movement of the bullet. This particular difficulty, it is true, was latterly overcome at Woolwich, by means of an ingenious apparatus for forming

bullets by compression out of cold lead. Every ball thus produced is necessarily of equal density and perfectly solid. Had it been possible to project bullets of this kind from an accurately straight and cylindrical tube, their flight, for moderate ranges, would have been tolerably true, could the windage at the same time have been prevented; but when the barrel, after a few discharges, became foul from the products of combustion, it would have been hardly possible to have fired many successive rounds.

Rifling, or grooving the barrel, originally devised to remedy this evil, was found, with certain subsequent modifications, to obviate others of still greater moment.

As originally practised, rifling consisted merely in ploughing a number of straight grooves or channels from the muzzle to the breech. This was done simply to allow of the escape of the residuum of the powder, and to facilitate loading. By degrees, and probably by accident, it was discovered that, when a tortuous direction was given to these grooves, greater precision in shooting was attained. The theory being, that the position of the axis of rotation of the ball not being dependent upon any accidental circumstance, but being rendered coincident with its line of flight, the resistance which the fore part of the bullet encounters from the air acting equally on all sides, is evenly distributed round the centre of gravity.

If, moreover, there chance to be irregularities on the surface of the bullet, its revolution on its axis presents them successively to the action of gravity and of the air; thus, in fact, tending to neutralize the deflection to which these defects give rise.

Spherical bullets may be regarded as obsolete; we may, therefore, dismiss them from our consideration; but rifling is, nevertheless, found, for the reasons

already stated, to contribute most materially to the precision of the elongated projectiles now in use.

To German ingenuity we are indebted for the earliest specimens of rifling extant, and we may regard the rifle as a production of the latter part of the fifteenth century.

The change in the grooving from the straight to the spiral was speedily followed by variations of all kinds in the number of channels, as well as in their inclination. These changes were prompted rather by the fancy or caprice of the gunmaker than by any sound philosophical views.

About 350 years ago, one Koster, of Nuremberg, enjoyed a high reputation for the superior workmanship of his barrels, in a country and at a time when target-shooting was becoming a favourite diversion. But it is to our own countryman—Benjamin Robins, a mathematician of great eminence, who died in 1751—that we are indebted for the most elaborate researches, and one of the best treatises extant, even at the present day, on the subject of gunnery.

He observes, "that the degree of spirality, the number of threads, or the depth of the channels, is not regulated by any invariable rule, but differs according to the country where the work is performed and the caprice of the artificer." He then proceeds to describe the various modes of loading; adding, "But in some parts of Germany and Switzerland an improvement is made by cutting a piece of very thin leather or fustian, in a circular shape, somewhat larger than the bore; this being greased on one side, is laid upon the muzzle with its greasy part downwards, and the bullet being placed upon it, it is then forced down the barrel with it. The riflings should for this purpose be shallow, and the bullets not too large.

"As this mode of loading took up a good deal of

time, the rifled barrels made in England," continues Robins, "(for I do not remember to have seen any foreign rifles so constructed) are contrived to be charged at the breech, where the piece is made larger, and the powder and bullet are put in through an opening in the side of the barrel, which, when the piece is loaded, is fitted up with a screw;" adding, with singular sagacity, "somewhat of this kind, though not in the manner now practised, would be *of all others the most perfect method* for the construction of these sort of barrels."

We find then, the opinion of this able experimentalist, coinciding remarkably upon this point with that of some of the most scientific men of the present day, and in all probability the time is not far distant when muzzle-loaders, whether for sporting or for military purposes, will be entirely superseded by a revival of the simple principle just alluded to.

Since the days of Koster, rifles in endless variety have been produced with grooves of different depths, and numbering from two to forty, or even more. We have had them also without any groove, as in the case of the elliptic bore (now commonly known as Lancaster's), or as in the hexagonal bore lately introduced by Whitworth, the celebrated engineer.

Successive enthusiasts have recommended with equal confidence barrels of small and of large diameters; each individual professing to have discovered peculiar merits in the one advocated by himself.

The Americans, the Germans, the Swiss, the Tyrolese, all have their favourite weapon; but speaking advisedly and without prejudice, and after having fairly tried those of every nation, I have no hesitation in asserting that neither in workmanship nor in precision and range are there any foreign fire-arms that

will at all equal those turned out by the best English makers.

The Kentucky rifle, usually of small internal diameter, will, it is true, work admirably up to perhaps 300 yards. German rifles may be met with, of still larger bore, that will send a ball, with tolerable precision, considerably further; and the Swiss and Tyrolese having adopted cylindro-conical bullets, are gradually extending and improving their practice; but as yet I am very confident that they are for the most part considerably behind us.

The rifling, known technically as the "gaining" or "gathering twist," is said to be of American origin. In barrels on this construction, the spiral is slight towards the breech, increasing, and in some instances very rapidly, towards the muzzle. Having tried numerous rifles on this plan, I quite concur with General Jacob in his condemnation of the system, and would recommend no one again to waste money by experimenting in that direction. The principle in question is obviously unphilosophical, for, besides altering the shape of the bullet, it causes increased resistance at the muzzle, the very place where relief is wanted.

With regard to the length of barrel, there will probably always be a great variety of opinion. It is palpable that the effect of all errors affecting the flight of the ball, either on the part of the shooter or of his rifle, "must be proportionate to the time during which the causes act; thus the effect of the recoil must be twice as great in a rifle forty inches long as it would be in one of twenty inches, for the gun must have been acting on the shoulder, and the unsteadiness of the hand must have been acting on the gun, twice as long in one case as in the other. Being greatly

averse to anything superfluous about a rifle, whether intended for military or for sporting purposes, I strongly deprecate a needless weight of metal at a part where it can be of little, if of any, service; though too much solidity, too much iron, within reasonable limits, cannot well be given to the barrel in the vicinity of the chamber; while the lower part of the breech should be made at least of twice the usual thickness, if you wish to save your shoulder from the effects of the recoil. As a general rule, the heavier the rifle (that is, from 7 to 10 lbs.) the steadier and firmer it can be held, and consequently the better it will shoot.

There is no greater fallacy than to expect a light rifle to perform well at long ranges and with strong charges.

It may be assumed, indeed, as an established fact, that with a rifle, the grooves of which make one turn in a length of twenty-four or of thirty inches, any length of barrel beyond the complete turn adds nothing to the precision of the arm; though, in the case of a military weapon, it may be of advantage in a bayonet-charge, and in enabling the bullet to receive some additional impulse from the explosion. But, let the twist be what it may, 33 inches is the utmost length to which it can ever be advisable to extend the barrel, where shooting is alone the consideration.

The strain experienced by every gun at the moment the charge is ignited is not due in any degree to the friction of the bullet, but arises from the *vis inertiæ* exercised by it before it is started.

In a long barrel with a rapid turn, the resistance offered to the movement of the bullet as it is driven forward becomes very great at the muzzle; and though moderate charges show good results, better elevation will not be attained by increasing the

charge; but if the barrel be reduced in length, then heavier charges improve the elevation.

As for the degree of twist, I have never found any less rapid spiral excel the one above alluded to, and first suggested by General Jacob—viz., one turn in 24 inches. Mr. Whitworth informs me, indeed, that, with his hexagonal bore, one turn in 20 inches answers best.

The two-grooved rifle has, in my opinion, many glaring defects, where anything like long range is required.

The two-grooved, or, as it used to be called, the Brunswick rifle, if used with a cylindro-conical bullet, will undoubtedly perform better than with the belted ball; but under no circumstances have I ever seen it make even tolerable shooting at distances much exceeding 300 yards. It cannot, therefore, come into competition with arms of such range as those we now possess.

The rifle with four grooves has all the advantages claimed for those having a greater number, while it is decidedly superior to any barrels with three grooves; but these, as also the elliptic, we shall consider presently.

Summing up, then, in a few words, the substance of the preceding observations, the following facts, in connexion with the rifle, may be considered as thoroughly established.

1. The twist should be uniform, from breech to muzzle, and should not make less than one entire turn in two feet.

2. With one turn of the rifling in twenty-four inches, the barrel need not exceed two feet in length; nor, under any circumstances, need it be longer than thirty-three inches.

3. A rifle with four grooves is preferable to one

with any greater or smaller number. And I may add, fourthly, that the grooving should only be of a sufficient depth to ensure the spinning of the ball, and—other things remaining equal—shallow give better practice than deep grooves. Yet brief and simple as these conclusions appear, those few lines comprise the condensed results of tens of thousands of experiments, extending over a long series of years. Without adverting at all to my own investigations, it is but offering a well-merited tribute to the memory of the late General Jacob, who expended a considerable fortune, and devoted the best years of his life to the perfection of the rifle, to say that the country is indebted to him for one of the most powerful and beautiful arms that has ever yet been devised; an invention which, with all the generosity of his noble nature, he placed freely and unconditionally at the disposal of the Indian Government.

It will scarcely be credited that this invaluable offer was stolidly rejected, though its acceptance would have obviated one of the alleged causes of the Indian mutiny.

The Enfield and the elliptic-bored rifles demand particular attention, because both may be classed under the denomination of "regulation arms;" and for some time to come, one or the other will unquestionably be the weapon provided for the British army at large, as well as for Volunteers.

It was indeed high time that our gallant soldiers should be provided with something better than that wretched implement, the much lauded "Brown Bess" of other days. It was, in fact, the very clumsiest and worst contrived of any firelock in the world. It required the largest charge of powder and the heaviest ball of any; yet, owing to the absence of every scientific principle in its construction, its weight and

windage were the greatest, its range the shortest, and its accuracy the least; at the same time that it was the most costly of any similar arm in use, either in France, Belgium, Prussia, or Austria. The French and Belgian were supplied for less than 30*s*., while ours cost 3*l*. In fact, as a gallant veteran, alluding to this subject, lately observed, "he believed a man could securely sit in a chair, at 200 yards distance from another, who might blaze away at him all day with one of these muskets, on the sole condition that he should be bound upon his honour to aim at him carefully every time!" Other military men of experience have gone so far as to state, that the ratio of the probability of hitting a man with a musket-ball at 500 yards, would bear about the proportion of the national debt to a farthing. Yet, for all that, this was the arm with which our gallant British soldiers were sent forth to do battle not many years ago; and, if anything were needed to convince us of their prowess, it is the fact that with this wretched implement they somehow contrived almost invariably to beat armies, often far better equipped than themselves.

But will anything excuse the absurd tenacity with which our military authorities pertinaciously clung to their miserable firelock long after science had again and again indicated the means of providing the army with small-arms of tenfold greater power?

Now that our troops have a tolerably efficient arm, and understand its use, we may be sure that they will give a still better account of their opponents than they could do of yore, when, taking the average of a long series of engagements, only one musket-ball out of 460 was found to take effect.

The Enfield rifle, as adopted in 1852, admirable in many respects, and well-fitted as it is for the purpose

for which it is constructed, will not compete in precision with such rivals as Jacob's, Whitworth's, or even with some others less generally known; but it can be relied upon at ranges of 600 and 800 yards, and in very steady hands at still further distances.

The barrel of the common Enfield rifle is 3 ft. 3 in. long (the one known as the short Enfield is 6 in. shorter), the bore is cylindrical, the grooves, three in number, are (·115) rather more than eleven-hundredths of an inch in depth, and (·230) not quite a quarter of an inch in width. In the long Enfield, the rifling makes just one half-turn from breech to muzzle.

The service charge is $2\frac{1}{2}$ drachms * (or rather more than 68 grains) of fine-grain powder; the weight of the ball is 530 grains, and its diameter ·568; but this has been lately reduced to ·550, in order to facilitate loading. It should be borne in mind, however, that this diminution materially increases the windage—that is, the space between the bullet and the interior of the barrel; and increased windage, necessarily occasioning a loss of part of the power of the powder, of course very materially reduces the range. Major Nuthall, of the Bengal army, an officer of great experience and scientific attainments, has devised a far

* Powder and shot are weighed by avoirdupois weight:—

$27\frac{11}{32}$ grains = 1 drachm.
16 drachms = 1 oz.
16 oz. = 1 lb.

The following table of grains is given, that this may be clearly distinguished from other weights:—

Troy.	Apothecaries.	Avoirdupois.	
24	,,	,,	= 1 dwt.
,,	20	,,	= 1 scruple.
,,	60	$27\frac{11}{32}$	= 1 drachm.
480	480	$437\frac{1}{2}$	= 1 ounce.
5760	5760	7000	= 1 pound.

more ingenious and efficacious method of solving the difficulty. He slightly hollows the cylindrical sides of the bullet, leaving two thin rings of lead at either extremity of the cylinder, to serve as guides or bearings while loading, and to prevent excessive windage. I may also mention here that he has originated an improved system of rifling, which may be thus described:—

Instead of leaving the edges of the "lands" sharp and angular, he rounds them, and gives them also a curved outline to the grooves themselves. The expansion of the lead is thus greatly facilitated, while the friction is diminished. This form of rifling is entirely new, and is found in practice to answer most satisfactorily; and Major Nuthall was lately engaged, at the request of the War-Office, in converting some of the old muskets in store, into serviceable rifles—a most important undertaking, seeing that the manufactory at Enfield, and all the appliances of private makers here, at Liège, and in America, are far from sufficient to meet the demand that has of late sprung up for rifles of the Government gauge.

The Enfield, differs from the Jacob, in admitting the use of a thinner barrel and a slighter twist; the tube, however, must be larger, to allow of the action, for as long a time, of as much projectile force upon the bullet, as the barrel will bear without injury. But the form of the bullet, and its inferior momentum, prevent it from attaining such ranges as the Jacob; one main advantage of which is found in its low trajectory, a matter of extreme importance, as I shall presently endeavour to explain.

The construction of the Jacob bullet, it is true, gives it a strong tendency to turn on its longer axis during its flight; but this inclination is entirely counteracted by the great twist of the rifling, and the

strong and rapid spiral motion thereby imparted to the projectile. All things considered, no better arm has hitherto been produced for Volunteers than the one lately devised by Mr. Daw. Externally it resembles the Enfield in every respect, while it will carry the regulation ammunition, though it, of course, exhibits still better results with bullets constructed upon Jacob's model. The barrel is, in fact, an elongated Jacob, the superfluous nine inches being added only to enable it to carry the bayonet, and to range with the Enfield on the formation of companies into line.

Where, however, all the members of a corps are to be equipped alike, and where no importance is attached to the adoption of the short Enfield, they will find it preferable to provide themselves with the rifle as perfected by General Jacob shortly before his death. It has a stout 24-inch barrel, and side bar to carry the sword-bayonet, if that appendage be deemed essential.

Several volunteer corps have, upon my recommendation, been armed with these, as also with the improved Enfield Jacob; and I have little doubt but that, in any future trial of skill, their owners will be formidable competitors in target-practice with those who are merely furnished with the common regulation arm.

As for the elliptic-bored rifle, ordinarily looked upon as a new invention, it should be known that, so far from that being the case, it was regarded as antiquated, more than half a century since.

Colonel Beaufoy, the author of Scloppetana, one of the best treatises extant on the rifle, (published as far back as 1808,) observes:—

"While enlarging on rifles with grooves, let us not pass over a very old invention (though quite

obsolete in our time), which is, the method of making a plain-barrelled gun possess the advantages of the rifle, yet not be liable to detection unless more minutely examined than common inspection usually leads us to expect." He then proceeds to explain the peculiar mode of boring this kind of barrel, adding: "These barrels are loaded in the usual way, except that the ball should be sufficiently large to fill up the whole of the indentation; and it is said that such as are accustomed to these pieces will far outstrip anything that can be done with the common smooth-surfaced *cylindrical* barrel. It would be an improvement though, instead of using a spherical ball with these pieces, if it were rather of an oblong shape."

During a long series of experiments both at Malta and at Chatham, the elliptic rifle always maintained a marked superiority over the Enfield, the grand result being, that the Lancaster gained altogether 15·88 "points;" the Enfield only 12·62. The greatest distance fired over was 600 yards. But the chief objection urged against the elliptic bore is, that at very long ranges the bullets often display such unaccountable irregularities, that the performance of the rifle cannot at all be depended upon; and in these days the desire to possess the most powerful and efficient arm that can be produced, precludes many from being content with those that are not to be depended upon for certainty, however great their range.

The rifle exhibiting, perhaps, the greatest peculiarity in its internal construction is Whitworth's.

The bore, as already stated, is hexagonal; and, instead of consisting partly of non-effective lands and partly of grooves, is composed entirely of effective rifling surfaces. The angular corners of the hexagon are always rounded, and either hexagonal or cylin-

drical bullets may be used indifferently. If one of the latter form be fired, it is immediately forced into the recesses of the hexagon, and is thus compelled to adapt itself to the curves of the spiral. The inclined sides of the hexagon offering no direct resistance, expansion is easily effected. If an hexagonal projectile, accurately fitted, be used, metals of all degrees of hardness, from lead, or lead indurated by an admixture of tin, up to steel, may be used without any detriment to the bore.

An exceedingly quick turn may be given to the rifling on this principle, as with the most rapid twist the projectile never strips. To prove this fact, and to try the effect of extreme velocity of rotation, a short barrel was constructed, in which the rifling completed one turn in every inch. Bullets made of an alloy of lead and tin fired from this barrel with a charge of 35 grains of powder, penetrated through 7 inches of elm planks.

Mr. Whitworth finding that all difficulty arising from length of projectiles could be overcome by giving sufficient rotation, and that any weight that might be necessary could be obtained by lengthening the projectile, adopted for a bullet of the service weight (530 grains) an increased length and reduced diameter. He thus obtained his comparatively low trajectory. This is obviously a great advantage, for the lower the trajectory, or the nearer the path of the projectile approaches to a horizontal line, the greater is its probability of striking an object of moderate height; thus in some measure correcting errors that may have been made in the estimation of distances.

For instance, if a rifleman, erroneously estimating the distance of an enemy's column, elevate his sight too much, his bullet will probably pass entirely over

the men, and fall harmlessly in their rear. But supposing the weapon he uses, to have a low trajectory, in other words, to move more nearly in a horizontal plane, an error in elevation, will of course be of less consequence, for his shot will most probably strike some part of the approaching column.

If a body of cavalry were to charge riflemen from a position 500 yards off, the Whitworth or the Jacob rifle would empty many saddles as they advanced, while the Enfield would unquestionably send a large proportion of its missiles in an arc far above their heads.

An objection is frequently urged both against Whitworth's and Jacob's rifles on the ground that the friction of the missile is enormous. Whether it be so or not it is unnecessary at present to determine; nor is it practically very material, if we but look at results.

Now, at Hythe, in April, 1857, the power and efficiency of the Whitworth over the Enfield rifle was estimated by competent authorities in the ratio of about twenty to one! At 1880 yards (or 120 yards more than a mile) it struck the target with force, when the Enfield made no hits at 1440 yards. At 1100 yards the Whitworth, in accuracy was on a par with the Enfield at 500; and when both were tried over a range of 500 yards, the superiority of the hexagonal bore was in the proportion of three to one. With 70 grains of powder it sent a bullet through 33 half-inch elm planks, and the projectile was then only stopped by a solid block of oak behind them. The Enfield, at exactly the same distance, and with precisely the same charge, only pierced 12 of these planks.

At 500 yards, the elevation of the Whitworth was 1 degree 15 minutes, that of the Enfield 1 degree

30 minutes. At 800 yards the Whitworth required only 2 degrees 20 minutes, while the Enfield had to be raised 2 degrees 45 minutes. To any one conversant with the rifle, the immense superiority of the target practice of the Whitworth over the Enfield will be sufficiently apparent from the few facts here cited. It now remains to be ascertained whether it is in all other respects adapted for service in the field. But, to make the matter plainer to those who may not hitherto have directed much attention to the subject of trajectories, I may state that, in a range of 500 yards only, the curve described by the Enfield is 3 feet higher than that of the Whitworth. In addition to these merits of the polygonal bore, the barrels rifled upon that principle possess great durability, showing no symptoms of deterioration after many thousand rounds. Indeed, steel bullets have been repeatedly driven through $\frac{3}{4}$-inch wrought-iron plates without causing the smallest damage to the barrel!

I will now cite one or two instances of the precision at long ranges of the Jacobite rifle.

On the 23rd August, 1856, General Jacob, Captain Scott, Mr. Gibbs, and Captain Gibbard met on the practice ground at Kurrachee to try the effect of General Jacob's rifle-shells at a range of 1200 yards. An ammunition-waggon was extemporized out of an old cart, and a charge of 100 lbs. of powder was stowed in it, in a deal box measuring only 4 feet by 2 feet; an object which could but have appeared a mere speck at such a distance. The morning was cloudy, the outline of the butt beyond the cart was dim and hazy, and the weather altogether so unfavourable, that it required a practised eye to discern the butt at all; and it was even proposed to defer the experiment. The ninth shell, however, from Mr. Gibbs's rifle—one

made by Daw, and only 32 gauge—exploded the powder "with the most brilliant effect."

On the 5th September of the same year, a similar experiment was tried at 1800 yards, with a box 10 feet square, containing 500 lbs. of powder. The twenty-first round from General Jacob's rifle (24 gauge), fired by Captain Scott, exploded the powder.

The rifles were on each occasion fired from the shoulder, without any extra support, the shooter standing up.

Better shooting than this was probably never achieved with any rifle or by any marksman.

Without, then, taking into account the fire-arms of other countries and of other inventors, we may for the present, afford to be content with those to which attention has here been drawn. There must, indeed, be limits to the performance of every rifle, owing to imperfect vision, want of steadiness in the hand, or inability of the shoulder to support the recoil caused by elongated projectiles and heavy charges of powder.

It may, therefore, be reasonably assumed that the requirements of most men desirous of procuring an efficient rifle will be amply met by one that, when accurately tested in such a way that it cannot be affected by want of steadiness on the part of the shooter, will deliver successive bullets within a circle—say of 3 feet diameter—at 1000 yards. Now, we know that Whitworth's or Jacob's will do much more than this; they are either of them, in fact, in skilled hands, more than a match for field-guns of common construction.

I have seen a great deal of the practice of both the Austrian and the French artillery, and yet I do not hesitate to assert that an ordinary marksman, armed with one of Jacob's carbines, need feel no apprehension in fighting, single-handed, either an ordinary

six- or nine-pounder, with its full complement of men and horses; for, taking advantage of inequalities in the ground, and availing himself of the cover to be found in almost any locality, he would easily be enabled to pick off, or disable every man and horse, or with an occasional Norton or Jacobite shell, to blow up the powder tumbril, without really incurring any very serious risk.

There is, in fact, no great practical difficulty in the matter. Every one has read with admiration the account given by Lord Raglan of the memorable feat of the gallant Lieutenant Godfrey (of the Rifle Brigade), who, on one occasion, in the Crimea, advancing with a few men, under cover of a ridge—the men handing him their rifles as fast as he fired—made such excellent practice at the artillerymen working two Russian guns, the shot from which fell fast and thick around him, that in a short time he actually silenced them both!

This simple incident proves incontestably what a formidable antagonist a rifleman really is, who has made himself master of his weapon, and has thorough confidence in it, as well as in his own skill.

I will now, at the risk of recapitulating what I have stated elsewhere, offer a few words of advice as to the purchase of a rifle. For the purposes of learning the drill, and for the ordinary muster on parade, any firelock externally resembling the regulation rifle will, of course, serve as well as the best—better, indeed; for the treatment rifles usually receive, especially in young hands—during the performance of the manual, and more especially of the platoon exercises, is quite enough, in a few months, to ruin irretrievably a highly-finished arm. In every corps, therefore, it will always be wise economy to have a number of old and comparatively valueless arms for the use of recruits. As

soon as the young volunteer has learnt what a delicate and beautiful instrument a good rifle really is—when he can appreciate the science that, in the course of centuries, has been brought to bear in perfecting every part, the simplicity and ingenuity it displays, no less than its tremendous power—he will, in all probability, take all the care of it that it demands, more especially if it be his own.

The first thing to be attended to in ordering a rifle is the length and bend of the stock. No man will ever shoot even tolerably with a gun, or with a rifle, that is not accurately adapted to the length of his arm and neck, and to the shape of his shoulder. Try any number till you find one that suits you exactly; have a pattern cut from this, out of a plate of zinc, or tin, and let the maker never after, deviate from it even to the extent of an eighth of an inch in any direction.

The weight in the barrel ought to be as much as you can bear without inconvenience. Let me repeat, as I have frequently affirmed before, that no good shooting at long ranges can be expected with a light barrel, at the same time that it is much more liable to injury than one of stouter make. The barrel should not weigh less than six pounds; it would be better still, if it weighed seven or even eight. The best material of all for barrels is not steel, but a peculiar quality of iron, technically termed "homogeneous iron." I never shot more successfully than with a rifle I once had, the barrel of which weighed nearly nine pounds. Let me here particularly impress upon every one intending to have a rifle made for him, the extreme importance of insisting that there shall be at least double the ordinary amount of metal in the breech behind the chamber. For some reason, there is the greatest difficulty in inducing gunmakers to

conform to this injunction; and yet nothing tends so much to diminish recoil, as a solid mass of metal at this particular part, to receive the concussion of the powder and to act as a shield to the shoulder.

It is plain, that if a man were to lie on his back, and in that position were to receive a blow from a sledge-hammer on the chest, he would very likely figure as a principal in a coroner's inquest; but were an anvil interposed between the hammer and the man's frame, any number of blows might be struck with impunity.

The percussive force of a couple of drachms of powder is of course far greater than that of the heaviest hammer; yet, as fire-arms are ordinarily made, there is comparatively little, to break the force of this blow, which might be so easily warded off.

Let there be no side vents below the nipple. Many gunmakers have a foolish propensity to perpetuate this useless absurdity. The mainspring should not draw more than 12 lbs., nor the trigger more than 3 lbs. I lately examined a number of new Enfield rifles destined for soldiers' use, the triggers of which required on the average 11 lbs. to fire the gun; and an old "Brown Bess" I have, needs a fore-finger that can draw 31 pounds. It may well be asked what probability can there be of accurate shooting with arms such as these?

Should the rifle be required by the pupil for drill purposes, and not merely for target-practice, it *must* have a metal rod; but nothing is more injurious to the rifling, than the constant use of these rods, especially in unskilled hands. A tough wooden loading-rod, with the "grip" well roughened, and with brass fittings, would answer every purpose except the one above indicated.

When cartridges are not employed, a stout brass

tube the full length of the barrel, with wooden funnel-shaped top, will be found very convenient for delivering accurately the precise charge of powder into the chamber. I am not an advocate for greased patches in rifle-shooting. I much prefer using a bullet (that fits the bore within three or four-thousandths of an inch) coated with a mixture of three parts lard, one part white resin, and one part wax, well boiled together, or, better still, with eleven parts of bees'-wax and one part *mineral* oil.* The bullets must be dipped into this composition, while hot from the mould, when a thin film—quite sufficient for lubrication—will adhere to them; but, curiously enough, the lubricating mixture will not answer at all (but will flake off), unless applied, when the temperature of the bullets is between 300° or 400° Fah.

The sights will be found to require the utmost care in their adjustment. In a rifle turned out at a low price it is unreasonable to expect that the maker can do more than adjust one, after fairly trying the rifle. The usual practice is to mark the other distances by a sort of rule of thumb, calculating from the one adjusted on the shooting-ground. But this will not do where really "fine practice" is required. In that case, from thirty to fifty rounds should be fired from a properly constructed rest, using carefully *weighed*, not measured, charges of powder and bullets, all of precisely similar weights. To sight a rifle in this manner faithfully, and as it should be done, up to 1200 or even 1000 yards, will occupy several days; and it is a task requiring so much skill and patience, that few are qualified to undertake it.

There are minuter points connected with a rifle, which it would occupy too long a time to detail; but

* Obtainable at Price's candle manufactory.

those above recapitulated are the most important, and the rest may fairly be left to the judgment and discretion of any good gunmaker.

As for purchasing a rifle ready-made, that is a matter at this juncture requiring more than ordinary caution.

Never, in modern times, has there been such a sudden demand for arms of a particular class—never, consequently, was the market inundated with such an amount of trash. Many accidents have already occurred from want of common prudence in the selection of rifles; combined with that unfortunate passion for economizing, to the extent even of a few shillings, in a case where a defective article may occasion the most frightful mutilations.

I have seen things, externally and at a distance resembling rifles—got up by unprincipled salesmen or ironmongers—that would infallibly burst (as indeed they constantly do) if loaded with a double charge. Some of those I allude to, had not even the semblance of a proof-mark upon them!

Supposing that the reader has at last become the possessor of a weapon that, so far as weight, length, and bend of stock, pull of trigger, &c., suits him in all respects, he now naturally desires to learn how it can be used to the best advantage.

The old-fashioned plan was to begin firing away with ball at the distance of eighty or perhaps a hundred yards from the target; when, after many months' work, and an enormous expenditure of powder and lead, but without the least scientific information on the subject, the tyro in some cases became a tolerable shot, and perhaps ultimately a fair marksman at 300 yards: but, probably, never having had any instruction as to the proper mode of holding his rifle in the first instance, his success was much more a

matter of chance than of skill, and he consequently could never feel any great amount of confidence in himself.

Now-a-days, however, if the beginner will but keep in mind the principal laws that govern the movements of all projectiles, consenting for a few weeks to abstain from ball-cartridge, but sedulously practising in the meantime the drill, that will be hereafter described, he may reckon, almost as a matter of certainty, on becoming a really good shot. Should he after that be disposed to pay a visit to the target-studded plains of Hythe, where little is ever thought or spoken of but rifles, trajectories, cartridges, and lubricants; and where no one, be he who he may, is held in high esteem, unless he has taken a first-class in shooting, he will not be long in achieving for himself a high reputation, and may even in time hope to rival that prince of marksmen, Major-General Hay, whom I once heard described by a Scotch instructor of musketry as "the greatest of all airthly rifle-shots!"

CHAPTER II.

Uniform recommended by the War Office—Registered convertible tunic—Theoretical principles of musketry—Motion of projectiles—Influence on them of atmospheric resistance and of gravity.

It may not be deemed irrelevant here to mention that since the publication of the sixth editions of my works on the Rifle and on the drill of Volunteers, I have been urged by numerous correspondents to devise a simple and inexpensive uniform in lieu of what they designate as the unsightly one, said to have been suggested by the War-office Committee, and which some Lords-lieutenant have, it is reported, almost compelled certain luckless corps to adopt.

From various quarters it has been suggested that those who concocted the above dress must have been chiefly anxious to combine the appearance of a second-rate livery with a pauper's garb. The hue, a light drab, has been selected, it is reported, on account of its invisibility; but that object is defeated by the patches of scarlet that appear in bold relief upon the collar and cuffs. It must, I fear, be confessed that the whole affair conveys a sad satire upon the inventive powers and taste of the age.

The uniform I have designed is being largely adopted, and as yet no adverse criticism of any kind has been urged against it. It is considered to be peculiarly adapted for Volunteers, inasmuch as the tunic can be worn at any time as an ordinary morning coat, and is equally convenient either for walking or

PLATE 2.

THE CONVERTIBLE TUNIC.

(REGISTERED.)

[To face page 31.

riding; there being nothing about it that can attract observation.

When the wearer, however, has to attend drill or parade, it is only requisite for him to turn up the collar, and to button the coat; it then becomes at once an easy and convenient undress uniform,* quite sufficiently military in its character for a volunteer corps, but without any superfluity of braid or ornament to occasion needless expense, or to interfere with the movements of the rifle.

The engraving (Plate I.) on the opposite page will convey a very tolerable idea of this uniform.

The centre figure represents the tunic when used as an everyday garment, the other two figures indicate its appearance when converted; (by raising the collar, &c.) into a military uniform.

Presuming now that the reader, having provided himself with a rifle and some simple description of uniform, has made himself conversant with the platoon exercise, and has mastered that portion of the "preliminary musketry drill" which relates to the cleaning of arms, we may proceed to consider what are termed the THEORETICAL PRINCIPLES OF MUSKETRY.

If a rifled barrel of the regulation pattern, detached from the stock and with the breech removed, be examined in the most cursory manner, it will at once be obvious that the bore, though cylindrical, is not parallel to the external surface. The principal object of tapering the exterior is to diminish the amount of metal at a part where it is not essential to strength.

* I have unreservedly handed over the design, together with all the emolument that may ensue from the adoption of the uniform, to an army tailor; who, in return, has guaranteed to supply to all corps the best materials and workmanship, and not to deviate from the pattern which has been registered. He has undertaken, further, not to exceed the charge of 3*l.* 3*s.* for both tunic and trousers. His address is, J. Devick, 34, Dorset-place, Dorset-square, N.W.

One consequence is, that elevation is necessarily given in the act of taking aim.

Let a cap provided with two wires, crossing each other at right angles, be fitted to the muzzle, and let a plug of wood, perforated longitudinally and centrically, be placed at the part whence the breech was removed. If the eye be now directed through the tube to a distant object, to the point where the wires intersect, it will follow precisely the "axis of the piece" or "the line of fire." It is in this direction that the bullet travels with uniform velocity until it quits the barrel and becomes influenced by gravity and the resistance of the air. This is shown by the line A, C. (Fig. 1, plate II.)

The reaction of the atmosphere materially reduces the velocity of every projectile; and the greater the force with which it is impelled, the greater is the resistance it encounters; for the component particles of air, like those of all other matter, are impenetrable, though permeable. They may be compressed, parted aside, or rarefied, but they cannot be annihilated. The atmosphere is ponderable and elastic, and possesses either momentum or inertia, according as it may be in motion or at rest. It was not till Robins, in 1742, determined by careful experiment the influence of the atmosphere on moving bodies, that anything was really known on the subject. He found that a 24-pound shot did not range one-fifth part of the distance it would have attained in a vacuum according to the parabolic theory. Had the curve described by the bullet in its flight been a perfect parabola, it was clear that, when elevation was given to the gun, the angle of descent of the bullet should have been precisely equal to the angle of elevation; but this was not the case; Robins, therefore, naturally concluded that the error of the parabolic theory consisted in the

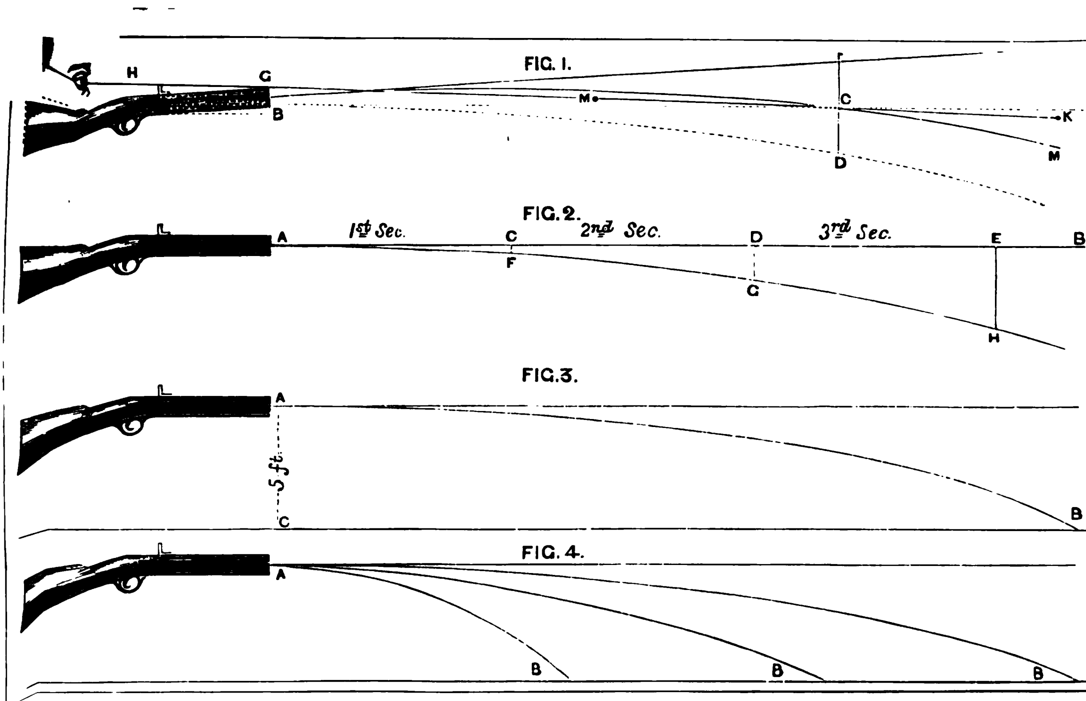


FIG. 1.
H
G
B
M
C
K
D
M
FIG. 2.
A
1st Sec.
C
F
2nd Sec.
D
G
3rd Sec.
E
H
B
FIG. 3.
A
5 ft.
C
B
FIG. 4.
A
B
B
B

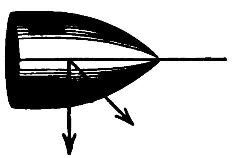
[illegible] of the bullet was

assumption that the motion of the bullet was uniform.

By firing at a ballistic pendulum, he was enabled to calculate by its oscillations, the velocity—at the moment of impact—of the ball projected against it. As he had anticipated, he discovered that the motion of the bullet became slower, as the distance between the gun and the pendulum was increased. This retardation could only be attributable to the resistance offered by the air.

Having demonstrated the fallacy of the parabolic theory, Robins next proceeded to undertake the difficult task of calculating the path actually described by the bullet.

The three forces acting on the various forms of projectile to which reference is here made—viz., gunpowder, gravity, and atmospheric resistance—combine to produce a force that constantly diminishes in velocity, causing the missile to describe a curved line (A.M. Plate II. Fig. 1), beginning at the muzzle of the piece, and diverging gradually in the direction of the attraction of gravity, till the projectile comes under the influence of that force alone.



It is obvious that the air, in resisting the progress of a bullet, is itself put in motion by the projectile; but whatever motion the air receives, must be proportionate to the amount of air moved, and to the velocity

Explanation of Fig. 1, Plate II.

A F represents the line of fire and axis of the piece when elevation is given to the barrel.

A C the trajectory or path of the bullet when the barrel is elevated.

H G C the line of sight.

C, point of intersection of the line of sight and trajectory.

imparted. If then the air be always similarly displaced, let the velocity of the bullet be what it may, the motion received by the air from the bullet must be proportionate to the square of the velocity of the bullet, and to the density of the air.

It is not surprising, therefore, that the diminution of motion, in the case of large shot and shells, should be so great as it is actually found to be. For instance, a cannon ball 4·50 in. in diameter, moving at the rate of 25 feet per second, sustains a resistance of 315 grains, or about $\frac{3}{4}$ of an ounce; but if to this bullet we communicate a velocity of 800 feet per second, or 32 times greater, the resistance it would then meet with, would be (32 × 32 times $\frac{3}{4}$ of an ounce, or 48 lbs. or) 4 times its own weight. With an initial velocity of 1600 feet per second, the resistance would amount to more than sixteen times the weight of the ball.

The resistance of the air, operating as it does uniformly and constantly, deducts four times as much from its velocity as its gravity would do in the same time. Now, were a bullet projected perpendicularly upwards, in one second, its velocity would be reduced from 800 to 768.

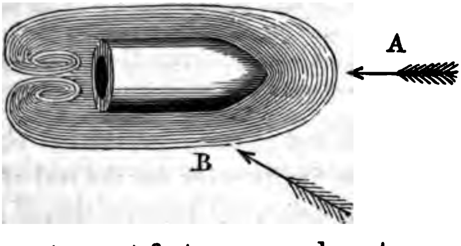
Atmospheric resistance, were its operation uniform, would bring it therefore, in the same interval, to 672; but as the resistance continually reduces the velocity, while it is itself diminishing at the same time, the actual diminution is about 127·75 feet. Thus in one second, the velocity will be diminished from 800 to 687.

To estimate accurately the effects of atmospheric resistance upon projectiles, we must regard it as a retarding force similar to gravity. We may thus compare it with any other such force by means of the *retardation* it produces under parallel circumstances.

We cannot, it is true, contrast it directly with gravity, by comparing the diminution of velocity which its uniform action produces in a given time, because when the velocity of a moving body is diminished by atmospheric resistance, the diminution takes place gradually, causing a gradual reduction of its intensity. Gravity, on the other hand, acts equally on a body, whether in motion or at rest. But both forces may be regarded as dead pressures.

In order to estimate the degree of resistance offered by the air, to bodies moving through it, we must not only bear in mind the law already cited, that such bodies impart to the particles of fluid with which they come in contact, a velocity deducted from their own, but they have at the same time to overcome the friction they generate, as well as the force of cohesion by which the particles composing the atmosphere are held together, these forces being both independent of the velocity.

Again, no particle of air, however minute, can be moved, without setting in motion many others, more or less distant from it. If, for instance, a bullet move through the air slowly, with uniform velocity, it must drive before it a certain number of particles of air, proportionate to the front it presents :—



These atoms, at first compressed as at A, soon take

a direction parallel to the lateral surface of the projectile, as shown at B, and ultimately close in its rear, like waves in the wake of a ship, thus filling up the temporary vacuum caused by the passage of the moving body.*

When the rate of motion exceeds two or three yards in a second, the air forms a series of vortices in the rear of the projectile, and they, rapidly succeeding each other, in some degree impel it forward.† The amount of the resistance of the air, is therefore, the resultant of the force in front, acting in opposition to gravity and to the force of the particles of air closing behind.

If the motion of the projectile be so great that the particles of air cannot immediately act in the manner above described, the resistance in front, is necessarily augmented, the anterior portion of the bullet having to bear the entire weight of a column of air equivalent to its own front, besides the force which sets in motion that portion of the fluid in contact with it.

The condensation of the air in front, must also be taken into account, as it materially influences the resistances and velocities of oblique surfaces.

It has been already observed, that the atmospheric resistance is materially affected by the magnitude of the surface of a body moving through it. In the case of spherical projectiles, the resistance is as the squares of the diameters. That the form of a moving body influences its rate of motions will be shown hereafter.

Galileo was the first to point out the real effect of gravity on falling bodies, and he proved that all projec-

* When the barometer stands at 30 inches, the velocity with which air rushes into a vacuum, is 1333 feet per second.

† See the lower fig., p. 42.

tiles would describe parabolic curves,* were their motion not interfered with, by the resistance caused by the air.

Gravity acts on all bodies, in proportion to the quantity of matter of which they are composed. The difference in the rate, at which bodies of various dimensions fall to the earth, is owing to the difference of the surfaces presented by them to the air. A ball of gold falls almost instantaneously, but beat the ball out into a thin leaf and it will descend slowly.

If the air offered no opposition to the movement of a projectile and the explosive force of the powder projected it from the muzzle of a rifle A, with a velocity

which should send it, in the first second to C, then during the second second, it would traverse an equal distance C, D. By the end of the third second, it would have reached E, and so on, continuing to move uniformly in the same line. But the air, thin and elastic though it appears, exercises as we have seen, a strong antagonistic power, in a horizontal direction, while gravity operates constantly upon it downwards, in a ratio that augments with the length of time that the bullet is exposed to its influence. Increased velocity, causes a body to attain distances proportionate to the squares of the time occupied in traversing the different spaces.

One consequence of this law is, that all bodies of similar figure and of similar density, at equal distances, fall at an equal rate. Thus, if a ball dropped from a height, traverses, as it will, 16 feet in one second, in the next it will fall 48, in the third 80 feet, or a total

* A parabola is the figure formed by the section of a cone in a plane parallel to its side.

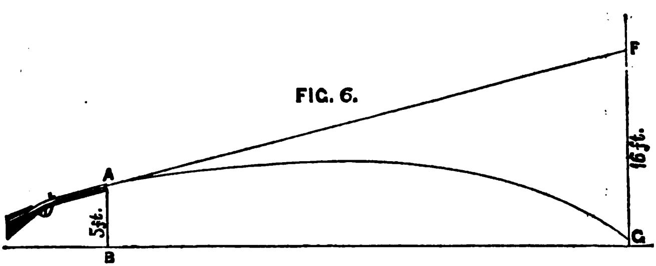
of 144 feet in three seconds. It will be obvious therefore, that a projectile, like any other falling object, instead of moving in the straight line A, B, (Plate II. fig. 2), will follow the direction of the curved line, A, H; the points F, G, H, representing, roughly, its position at the end of the first, second, and third seconds.

Were a rifle fired horizontally, the ball, whatever were its velocity or range, would strike the ground, in precisely the same time that it would have reached the earth had it been simply dropped from the muzzle. That is to say, the bullet would reach B, (Fig. 3, Plate III.) in the same time that it would take to fall from A to C.

If three rifles, all laid horizontally and loaded respectively with 1, 2, and 3 drachms of powder and similar bullets, were simultaneously fired, the three projectiles (B, B, B, Fig. 4, Plate III.) would strike the ground at the same moment, though their initial velocities and ranges would of course be very dissimilar.

When elevation is given to a gun, the missile projected from it, will strike the ground in the same time that it would take to fall the length of the line of the angle of projection. Thus supposing F, G, to represent an elevation of 16 feet from the horizontal line B, G,

FIG. 6.



and the muzzle A to be raised, the ball would reach G in one second, however great the distance might be from A to G. Or if the rifle were raised 16 feet and then fired horizontally, the ball would still reach the ground in the same space of time.

From experiments made by a French Military Commission, it was found that the greatest range of a globular bullet, fired from the regulation musket was attained when an elevation of 25° was given. Theoretically, the angle should have been one of 45°. The ordinary velocity of a bullet was proved, on that occasion, to be about 1500 feet per second. In an absolute vacuum, it would have been about 59,376 feet, or rather more than 10 miles per second.

At an elevation of 4° 30′, the range was 640 yards; in vacuo it would have been 3840 yards.

We may now consider to what extent the resistance encountered by projectiles is influenced by their form.

This inquiry involves various problems of much intricacy; and though the subject has been deeply investigated, it must be confessed that we are still without any very great amount of definite knowledge on the subject. The information we do possess, is due rather to practical experiments than to philosophical deduction. One fact, however, may be regarded as conclusively established—namely, that the spherical form is about the worst that could be devised for any kind of projectile.

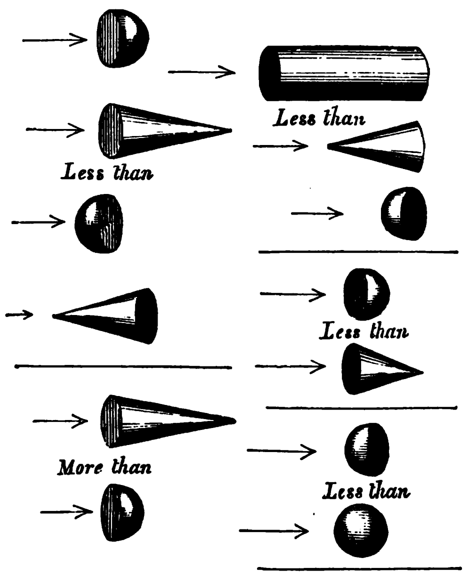
Captain Boxer, in his admirable treatise on Artillery, gives the following results of experiments with slow motions.

1. That the resistance is nearly as the surface, increasing slightly above that proportion, in the greater surfaces.

2. That the resistance to the same surface, with

different velocities, is in slow motions nearly as the squares of the velocities, but gradually increasing as they increase.

3. The round ends and sharp ends of solids, suffer less resistance than the flat or plane ends of the same diameter. Hence the flat ends of cylinders, of hemispheres, or of cones, suffer more resistance than their round or sharp ends.



4. The sharper ends have not always the smaller resistances; for instance, the convex side of a hemisphere, meets with less resistance than the pointed end of a cone, whose angle with the axis is 25° 42′.

5. When the hinder parts of bodies are of different forms, the resistances are different, though the fore parts are the same; thus the resistance encountered by a hemisphere is less than that offered to the whole sphere.

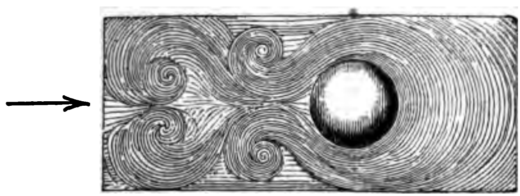
These laws will be rendered more intelligible by the figures on the preceding page.

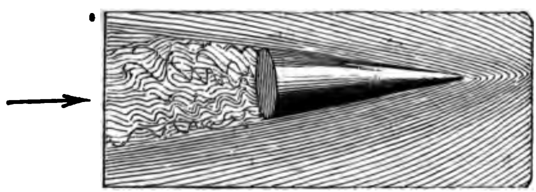
It must, at the same time, be borne in mind that they have reference only to the movement of bodies at very low velocities. At higher rates, for reasons already adverted to, the form of the rear of the projectiles influences the amount of resistance very remarkably.

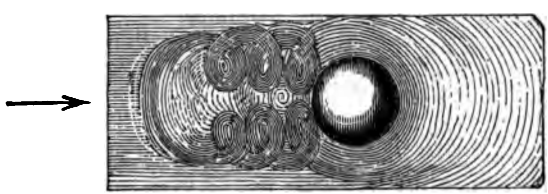
The impact of the surface of a projectile, causes the particles of air with which it comes in contact, to diverge in different directions, according to the inclination of the surface, the air of course moving in the opposite direction. Hence the resistance to the fore-part of a cylinder is less than that on the equally flat surface of the cone or hemisphere of equal diameters, owing to the form of the base of the cylinder. As shown in the diagram opposite, the base of the hemisphere experiences less resistance than the cone, and the spherical side of the hemisphere less than that of a ball of the same diameter.

The angle of reflection being, under all circumstances, equal to the angle of incidence, the atmospheric particles would move in straight lines, were they not affected by the surrounding fluid. The movement of the projectile, necessarily causes a partial vacuum behind it, as shown in the woodcuts in the next page; the surrounding air, consequently having a tendency to rush into the space thus formed, will re-act upon the particles first struck, materially altering their direction. Hence it is plain, that that form of projectile which will give to the particles first encountered the least divergence from

a direction parallel to its own motion, will allow the vacuum to be filled in the shortest time, and will, at the same time, be the least likely to cause a condensation of the atmosphere before the projectile. But there is a limit to the extent of the surface of the fore part of the bullet. If it be too great, the increase of friction will more than counterbalance the advantages







arising from its form. That form, for the hind part, will be most advantageous, which is calculated at high velocities to receive the greatest pressure. Experiment has demonstrated that the shape best suited for the

anterior part—or, as we may term it for distinction, the apex—is the conoidal form, finally decided upon, after many thousand trials, by General Jacob.

The utmost ingenuity seems to have been exercised, in America as well as in Europe, in giving to projectiles, every form that could be devised. They have been made of lead of different degrees of purity, and bullets of that metal have been composed in combination with steel points, iron cups, discs of wood, horn, and even of leather. Some have been cast with grooves varying in depth and number, while others have been so formed at the base, as to receive, or to be intended to receive, when fired from a smooth barrel, the requisite spin upon their axes, from the medium through which they passed.

Of the almost innumerable varieties of bullets that have, from time to time, been brought forward by different inventors, a selection will be seen in a subsequent chapter. Foremost among these, is the one originally suggested upwards of 30 years ago by Captain Norton, who offered it to the authorities at the time. They unfortunately, blindly rejected it, either from want of discernment of its merits, or prejudice, though with strange inconsistency, their successors awarded in 1858, £1000 to Mr. William Greener "for the first public suggestion, in 1836, of the principle of expansion for bullets, commonly called the Minié principle!"

Mr. Greener's bullet was in form, an oblate spheroid, having a cavity that extended from the base, beyond the centre, into which was loosely fitted a conical plug, with a broad flat head. When fired, this plug was driven home, forcing the sides of the bullet into the rifling, and preventing all windage. It undoubtedly afforded much facility in loading, while its precision at moderate ranges was very great.

Had Captain Norton's invention but received, when first introduced, a share of the attention its importance warranted, England would not have had the honour snatched from her, of having initiated the greatest improvement in firearms, nor would justice have been so long denied to the gallant veteran whose ingenuity suggested it; for, after more than a quarter of a century of experimentalizing, and after all that thousands of scientific men during that interval have achieved, we are forced to admit, that the most perfect rifle-bullet now in use, call it by what name we please, owes all its power, its precision, and range, to the principles demonstrated so long ago by Captain Norton to be essential to all such projectiles—that is to say, to elongation of form and absence of windage. I hold it, indeed, to be immaterial to the *principle*, whether the annihilation of windage be caused, as in the Enfield rifle, by the expansion of the bullet into the grooves of the barrel, or whether a projectile be used, which at the time of loading is already fitted with mathematical accuracy to the rifling, as in the Whitworth and the Jacob. Practically, the latter is, n my opinion, far preferable; and I have very little doubt that, before the lapse of many years, we shall find that the expansion system has given place to the one that may be considered as having virtually beaten it out of the field.

Colonel Beamish, adverting, some eight years since, to the treatment Captain Norton has experienced, aptly observed:—

"It is interesting to trace the progress of human invention, to observe the unaided struggles of genius, the frowns of fortune, the rebuffs of ignorant officials, 'the hope deferred,' the assumption, presumption, and jealousy of rival aspirants, until the name, and fame, and identity of the original inventor are mystified

and overlaid by modern pretenders, and the public are left in the pleasing predicament of not knowing 'which is which.'"

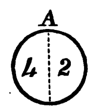
I shall, however, hereafter enter more fully into this subject.

In all probability, in the present state of science, a better mode of determining the most perfect form to be given to bullets of any kind, will not be devised, other than that afforded by carefully conducted experiments. The correctness of every theoretical formula is affected by so many circumstances, allowance for each of which must always to a great extent be hypothetical, as to render all deductions from them hazardous and uncertain.

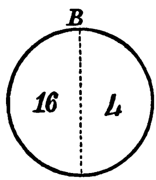
That the elongated, is far preferable to the spherical bullet, cannot now for a moment be questioned; but opinions are divided as to the proportion which the length should bear to the diameter. General Jacob after determining to his satisfaction that the cylindro-conoidal bullet approached, nearest of any, to perfection in shape, took some pains to ascertain the proportions of the conical and of the cylindrical parts to the diameter of the barrel. After many trials he found that each should be $1\frac{1}{2}$ diameters in length, so that the entire bullet is 3 diameters long. The Enfield is little more than $1\frac{3}{4}$ diameters, while the Whitworth (hexagonal) is rather more than $2\frac{1}{2}$, while Whitworth's tubular hexagonal is just $3\frac{1}{2}$ diameters long. It is obvious that the axis ought to be maintained in the direction of the trajectory, if we would attain the minimum of resistance, otherwise the projectile will exercise a continual tendency to revolve upon its shorter axis. A conical bullet traverses the air with greater facility than one of a globular shape, or one having an obtuse extremity. But if it be *too* pointed, the centre of gravity is thrown back, a material defect; and singularly enough, its power of penetrating solid

matter is diminished. Thus, Mr. Whitworth found that for perforating iron plates a steel bullet, with a flat, blunt extremity, answered the purpose far more satisfactorily than one terminating in a sharp point. If the surface be too great, the friction will materially interfere with range, while, as has already been shown, the resistance of the air will be augmented.

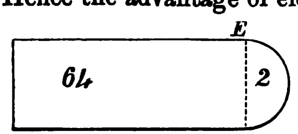
To exemplify this; the superficial area of circles is approximately proportionate to the squares of their diameters:—



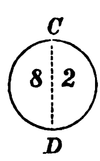
Thus, if A, represent a ball 2 in., and B one 4 in. in diameter, the amount of resistance offered to them respectively, by the air, will be as 4 to 16.



The power, in bodies of similar form, of overcoming resistance is as their densities. The cubical weights of spheres, composed of the same material, is in direct proportion to the cubes of their diameters. Thus, the power in this respect possessed by B and A would be as 84 to 8. The power of overcoming resistance increases, therefore, in much greater proportion to the resistance occasioned by increasing the surface. Hence the advantage of elongating a projectile, is obvious.



If we suppose one, partly cylindrical, as E F, equal in diameter to A, but elongated, until its weight equals that of the ball B, it is clear that while the resistance of the air would be the same as that encountered by A, it would possess as much power as B to overcome that resistance.



But this advantage is purchased by increased friction.

Experiments have been tried in France with rifle bullets of great length, even up to five inches. The result was, great range and accuracy, but excessive recoil. Whenever, therefore, bullets of this kind are to be used, the barrel must at the same time be increased in weight and strength.

Captain Delvigne attempted to gain some of the advantages of long projectiles, without the drawback of weight, by hollowing the cylindrical portion of his shot, thinking by this means not only to throw the centre of gravity forward, but also to cause expansion into the grooves of the rifling, at the moment of explosion.

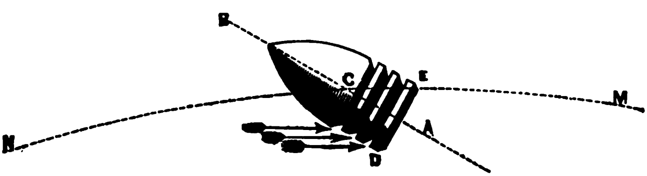
He obtained a patent for this invention in June, 1841, though Captain Norton had in a great measure anticipated the idea eighteen or twenty years previously, in consequence of having observed the action of the darts, headed with pith, projected by the Malays from their blow-tubes.

It has been found, that too great a cavity, producing too much expansion, gives rise to enormous friction against the sides of the barrel, while, if the hollow be too slight, no expansion takes place at all. To Captain Minié the credit is due of having suggested the insertion of an iron cup into the base of the bullet, to prevent the explosive force of the gas from forcing its way through the centre of the lead, an accident previously of constant occurrence. He also subsequently added a groove round the circumference of the cylinder, simply with the view to attach, with greater facility, the cartridge or the patch to the projectile. But the adoption or omission, and even the position of the groove, were found materially and most astonishingly to affect the precision of bullets made upon this system.

Captain Tamissier, after having for many years devoted his attention to the subject, was induced to

make several alterations in the length of the cylinder, and also in the angle of the cone, mainly from a desire to do—what Robins had recommended a century previously—namely, to throw the centre of gravity as far forward as practicable. In so doing he, however, flattened or thickened the fore part of the bullet, whereby it encountered greater resistance than before. To remedy this defect, it occurred to him that the readiest plan would be to generate, at the base, such an amount of resistance as should operate in maintaining the axis of the bullet coincident with the line of flight. For this purpose, he grooved the cylindrical portion of the bullet with a number of shallow parallel furrows, and his ingenuity was rewarded by an increase of precision. It appeared, on further trial, that to maintain their form, and to increase the action of the air upon them, it was essential that these grooves should be extremely sharp; otherwise, in loading, they were obliterated by the blows of the rod. In this country, however, notwithstanding the repute it once enjoyed, the grooved bullet is no longer in favour. To exemplify its action, it may be observed, that if a projectile of elongated form, whose centre of gravity is not precisely coincident with the centre of figure, does not turn over, it will have a tendency to preserve its axis in the original direction in which it was set moving. Its trajectory will therefore be more elongated than that of a globular bullet of the same weight. Now the resistance of the air, acting upon the groove, produces a gradual action upon the low part, tending to bring the point, back into the trajectory; but as this action is the result of the pressure of an elastic fluid, it follows that the point of the bullet having for a moment been coincident with the trajectory, will descend, till the upper grooves, becoming acted

upon by the resistance of the air, the point will be forced upwards once more, to descend and rise alternately throughout the whole flight. This swinging motion is plainly seen in the case of an arrow when not moving with great rapidity. The action of the grooves is, in fact, a modification of that of the rudder upon a vessel. To illustrate the action of the air upon the lateral grooves of a projectile, let E, B, D, represent a bullet; M, N, its path through the air, or trajectory; A, B, its axis; and E, D, its base.



It is plain that the anterior part of the bullet B, D, is acting against compressed air, while E, B, is moving through a thinner or rarer medium, consequently the grooves in the direction of D meet the full resistance of the air, while at E they entirely escape its influence. By that resistance, B will gradually be brought below the line M, N; then the grooves between B and E, being subjected to the action of the air, will once more raise the apex B; and this oscillation must necessarily continue along the whole course of the trajectory.

With respect to the material for rifle bullets little need be said, as nothing has yet been suggested for general use comparable to lead.* For special purposes, and where it is required to perforate metallic sheathing, a projectile may be used, the forepart of

* The specific gravity of lead is 11·35, that of platinum being 20·98, of gold 19·26, and of iridium 18·68.

which is constructed of steel, or (with a suitable rifle) the whole bullet may be made of that metal.

Should, at some future time, any better material be obtainable at as easy a rate as lead, advantages in rifle practice would no doubt be secured proportionate to the increased density of our bullets. For the present, we must rest content with lead. Where, as in the Enfield rifle, the expansion principle is adopted, the lead cannot be too pure. But with rifles like those of Jacob or Whitworth, this is immaterial, and an admixture of tin or antimony will prevent the flattening of the bullet, without any risk of damaging the interior of the barrel.

Robins, in discussing the changes produced in its trajectory, by the rotation of a shot on its axis, observes, "that bullets are not only depressed beneath their original direction by the action of gravity, but are also frequently driven to the right or left of that direction by the action of some other force. If it were true that bullets varied their direction by the action of gravity only, then it ought to happen that the errors in their flight to the right or left of the mark, should increase in proportion to the distance of the mark from the firer only. But this is contrary to all experience, for the same piece which will carry its bullet within an inch at ten yards, cannot be relied upon to ten inches in one hundred yards much less to thirty inches in three hundred."

We thus see the fallacy of trusting to the accuracy of a rifle which has been shot and sighted at one hundred yards, the remaining sights having being filed or marked, almost at random from the first one.

"Now this irregularity can only arise from the track of the bullet being incurvated sideways as well as downwards. The reality of this doubly incurvated *track being* demonstrated, it may be asked what can

be the cause of a motion so different from what has hitherto been supposed?"

The first is attributable to the oblique action of the resistance of the air to the progressive motion of the bullet, and may sometimes arise from superficial inequalities.

Another cause is the rotary movement of the bullet upon its axis. This, combined with its progressive motion, causes each part of the surface of the bullet to strike the air in a direction very different from what it would do, if it did not thus revolve. The obliquity of the action of the air, arising from this cause, will increase or decrease, as the rotary motion of the bullet is greater or less, than its motion in the line of the trajectory.

As the aerial rotation must necessarily act concurrently, during one portion of its revolution, with the progressive motion, while in another it will oppose it, the resistance of the air to the anterior part of the bullet must obviously be affected receiving impulse at one point and retardation at the other, hence the obliquity above alluded to. Were the axis of rotation of the bullet perpendicular to the horizon, then the inclination would be to one side or the other. If it were horizontal, the deflection would be either vertical or the reverse. However, as the position of the axis is in the first instance uncertain, and as it may continually change during the flight of the bullet the deviation in question will not necessarily be continuously in one direction.

From this consideration the reader will at once perceive how it is that a rifle of the most perfect construction, loaded with the utmost care, fired successively from the most solid rest, and even receiving its elevation from the most delicately adjusted apparatus, will seldom, at any long range, deliver two or

more bullets upon the same spot on the target. Of course the smaller the circle of error, the more perfect is the implement.

The following excellent illustrations of the accuracy of Robins' theory of rotation, suggested in the Hythe Lectures, will perhaps convey a still clearer idea of this important law of projectiles.

If a wooden ball 4½ inches in diameter be suspended by a twisted double cord nine feet long, and receive a rotary motion as the string untwists, it will revolve in the same vertical plane. But, if it be made to spin, while vibrating, it will be deflected to that side on which the action of the whirl combines with the progressive motion.

By firing through successive and parallel screens of thin but strong tissue paper, erected at equal distances along the line of the trajectory, the amount of deflection can be observed and measured. In this experiment it will be found that the amount of deflection is not at all proportionate to the increased distances of the screens.

Robins, in order to carry demonstration still further, bent a gun barrel to the left, about 4 inches from the muzzle, at an angle—to the axis of the piece—of 3° or 4°. When a bullet from this bent barrel was fired through a number of screens, it traversed the first screen to the *left*, but finally struck the target to the *right* of the line of aim, taken along the straight portion of the barrel.

It is not, however, to be understood that the aerial and progressive motions of a projectile need necessarily disturb each other. One, indeed, may be considerably affected by external causes, while the other remains unchanged. If the direction of a force be through the centre of gravity of a body at rest, the motion imparted will be simply progressive. But if

it already had a progressive motion, it will move faster or slower, or change its direction according as the direction of the second force acts concurrently with, or in opposition to, its original motion, or operates upon it obliquely. If a projectile have at the same time a motion of translation and of rotation, the latter will not be affected by any new force that may trasverse its centre of gravity. Should the new force not pass through the centre of gravity, the motion of translation will be altered, as if the new force acted in a parallel direction, passing through the centre of gravity.* The projectile will in that case also acquire a rotary motion round an axis passing through the centre of gravity, perpendicular to a plane passing both through this centre and the direction of the force.

Now if we suppose a ball, perfectly spherical and solid, to be projected from a barrel which it fits accurately, without windage, the propulsive force of the powder would pass immediately through the centre of gravity of the shot, in a direction parallel to the axis of the bore, while the weight of the shot would cause but little friction. But whenever there is no windage, there must always necessarily be considerable friction; and as that is a force which acts upon the surface of the bullet antagonistically to the impulse given by the powder, axial rotation must ensue.

Again, if we load a barrel with a bullet, perfectly spherical, but having its centre of gravity near the circumference, the force of the powder would pass through the centre of the ball, in a direction parallel to the axial line of the barrel: but if the centre of gravity of the bullet should not chance to lie in the direction of the line of fire, a rotary motion round its centre of gravity will be imparted to the bullet.

* See Captain Boxer's Treatise on Artillery.

The angular velocity received by the bullet will depend both upon the length of the perpendicular let fall from its centre of gravity, in the direction of the impelling force and upon the density, or homogeneous character, of the metal of which the ball is made.

The direction of the rotation will depend upon the relative positions of the centre of the figure and of gravity.

The centre of gravity of any bullet may be roughly ascertained by floating it in a cup of mercury. If, while supported by that fluid, a mark be made with a pen, on the most elevated point upon its surface, and if it be then taken out and another mark be made upon the bullet at the spot on the lower surface, precisely opposite, an imaginary line uniting these two points will constitute the axis in which the two centres lie.

Sir Howard Douglas has ascertained from experiments with artillery, that whenever the centre of gravity was above the centre of the figure, the ranges were the longest, and when below the shortest, when to the right or left, the deviations were also lateral. With a cannon-shot in which the centre of gravity was not coincident with the centre of the figure, the range was 1,640 yards, while a shot precisely similar in all other respects, but having both coincident, ranged exactly 500 yards further. In shot of this description, that is to say, perfectly concentric, friction is the principal cause of deflection from the true line, but with eccentric shot, the mere rotation will produce deflection independently of friction.

I will now give a brief summary of the information intended to be conveyed in the preceding pages, relative to the principles which govern the movements of all projectiles, as these laws cannot be too strongly impressed upon the mind of the pupil.

First, then, the actual path of a projectile through the air differs very materially from what it would be in a vacuum.

Secondly. If, through this path or trajectory, we draw a perpendicular plane, passing through the culminating point of the curve, we shall divide it into two irregular segments, of which the one nearer the muzzle will approximate more closely to a straight line, while the other will be obliquely curved. The form of this curve may be studied by watching the course of a stream of water issuing from the hose of a garden or fire engine, when the tube is held at different inclinations to the horizon. The particles of water successively ejected, pursue a path precisely similar to that of all projectiles.

Thirdly. The curve of the trajectory fluctuates with the angle of elevation and the initial velocity given to the piece, and is more or less affected by the form of the projectile, its density and the position of its centre of gravity.

Fourthly. The greater the amount of matter contained in a projectile, the greater its momentum, and, other things being equal, the greater its range.

Fifthly. A projectile set in motion by a force that increases progressively, will attain a range, the limit of which will be determined when the atmospheric resistance equals the velocity of the moving body.

Sixthly. The point blank range will be at a greater or less distance from the muzzle, accordingly as the elevation is increased or diminished.

Seventhly. The object of the marksman is to make the point blank of his rifle as nearly as possible coincident with the object to be struck.

Eighthly. The trajectory necessarily cuts the line of fire at two points (the first at a short distance only from the muzzle), these are both termed points blank.

In order to ensure striking an object *within* the point blank, we must aim under it, if the object to be struck is beyond the point blank, we must sight above it.

Ninthly. Excessive windage, and the rotation to which it gives rise, are the chief causes of the inaccuracy of all firearms; the great object of all who have endeavoured of late years to add to their precision has, therefore, been to reduce the windage to a minimum.

CHAPTER III.

Aiming drill—Sights of English and French rifles—How to use the sights—Fine-sight, full-sight, half-sight—Sand-bag drill—Position drill—First, second, third practice—Kneeling—How to acquire steadiness in aiming—Snapping caps—Blank cartridge—New regulation blank cartridge—Recoil.

The pupil may now fairly be supposed to be in possession of the rudiments of a science, his proficiency in which will shortly be determined practically.

Should he have been so fortunate as to have obtained admission to the classes receiving instruction at Hythe, he will have a great advantage over those who have everything to learn upon their arrival at that institution.

Probably the first dictum he will there hear will be, that the less practice he has previously had with the rifle, the better shot he is likely, in a limited period, to become. This unquestionably is the case; for in shooting, bad habits of any kind are difficult to eradicate, and such is the Hythe system, that it does not admit of being grafted upon any other. Those who have been zealously engaged in maturing it, have left nothing to chance; they have ascertained by innumerable trials the best way in which every minute portion of the task to be executed should be performed, and no deviation, however slight, should be attempted from the directions laid down. By rigid adherence to them, far more than average proficiency in shooting is attainable without the expenditure of a single ball-cartridge. Paradoxical though

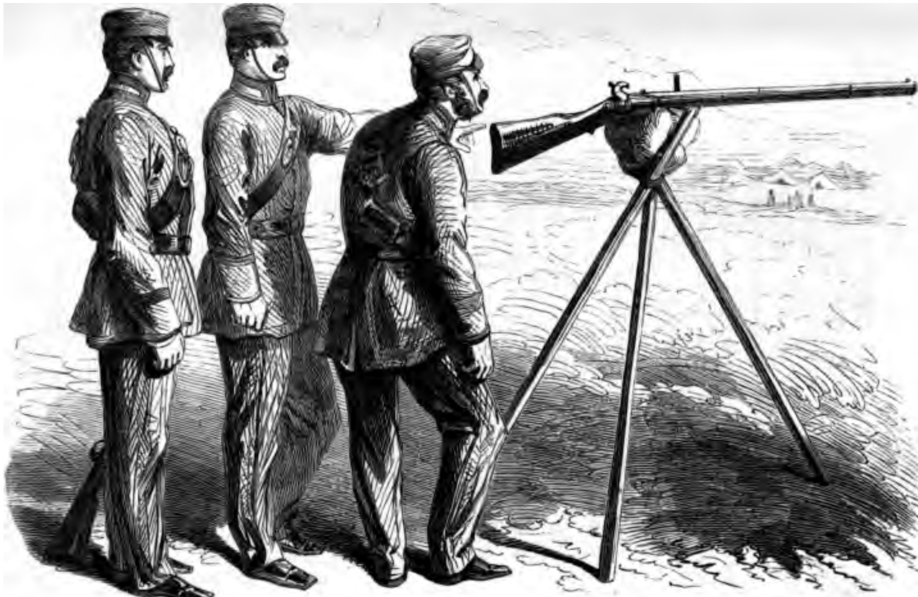
this may seem, it is nevertheless strictly true. It is only, however, to be accomplished by a course of AIMING and OF POSITION DRILL.

The first study of every one desirous of becoming an expert rifleman, must be the acquisition of an almost intuitive perception of distances, and in the next place, of a sympathetic action between the eye and the hand, so perfect that they will on all occasions act in unison without an effort. To aim accurately and promptly at a distant stationary object is not easy, much less at one in motion; and yet, in either case, all that is required, is to bring two points exactly into a line with a third. Unlike the rifle of the French soldier of the line, which is fitted with a permanently fixed back sight, requiring him to elevate or depress his piece, in a great measure at random, for all distances but one, the rear sight of every English rifle, from the common Enfield to the most highly-finished arm of the best maker, is provided with carefully graduated adjustments for ranges from 50 to 800 or 1000 yards. The muzzle sight is of course fixed, and for accurate shooting cannot well present too thin an edge to the eye. It should be placed with mathematical precision in a line with the axis of the piece, the direction of which ought to be marked by a hair line upon the barrel. A piece of steel tubing, browned, made to fit over this sight as a shade, will be found useful, both to protect the thin metal sight from an accidental blow, and to assist the eye while taking aim.

The mode of adjusting the back sights is readily learnt; but it is not easy to inculcate upon beginners the absolute necessity for holding them absolutely perpendicular, the slightest deflection rendering good shooting impossible.

The left eye being closed, the right eye, which

PLATE 4.



AIMING DRILL.

[To face page 59.

ought to be brought exactly to a level with the two sights upon the barrel, must be glanced through them at the object intended to be struck. Upon that object it must be intently fixed, when, after a few trials, it will be found that the muzzle-sight will, almost without an effort, cover the mark, whereas if an attempt be made in the ordinary way, to look from the muzzle sight to the object, it will not be nearly so readily seen, while the difficulty of aiming will be greatly enhanced.

The difference between fine-sight, full-sight, and half-sight having been explained, with the aid of diagrams, in "The Rifle, and How to Use it," it is only needful to state here that by *fine-sight* is meant that appearance presented by the muzzle-sight when its apex is just seen through the notch of the breech-sight; by *full-sight* its appearance when the apex in question is on a level with the uppermost horizontal part of the breech-sight; while *half-sight* implies a condition intermediate between the two, and is the kind of sight to which the beginner ought in the first instance chiefly to accustom himself.

He will now take three stakes, about six feet long, pointed at one extremity, and connected together about eight or ten inches from the other end by a stout ring, a lashing of cord, or any other contrivance that will admit of the formation of a sort of firm tripod, like that shown in the annexed engraving. In the fork thus constituted, a leather or canvas sand-bag will be loosely deposited. It should contain about half a bushel of sand, its use is to sustain in any position the rifle that is now to be balanced upon it. The pupil will proceed to aim the rifle at an object, say at forty or fifty yards distance, observing while so doing the rules already inculcated. The best mark for this purpose is a black upright post, with a

PLATE 1.

white background. If an instructor be present, he will examine the direction of the sights, point out any defect there may be in the alignments, show how the error is to be rectified, and how it is to be avoided for the future.

This practice should be constantly repeated at seventeen different distances, fifty yards apart; from 100 to 900 yards, for several days continuously. If the pupil have not the benefit of an instructor, he will find it an excellent plan, after having "laid" the rifle, to walk away and leave it for a few moments, for often upon examining it after a short interval, he will of himself discern his previous errors, and will improve himself even more rapidly than if he had had them indicated for him, and he will thus become perfectly conversant with the different sights, and the mode of using them. It is advisable also, after each exercise of this kind, to shut down the sight, and looking along the barrel, to note the elevation that the muzzle had received for each distance.

When the pupil has become perfectly familiar with the routine above described, he must now proceed to the second lesson, or

THE POSITION DRILL.

In this, the learner has, in the first place, to accustom the muscles of the left arm to support the weight of the rifle, to place the body in the most suitable attitude for firing, to raise the weapon steadily and quickly to the "present," pressing the heel-plate firmly against the hollow of the shoulder.

The proper place for the left hand—during the first practice—is about midway between the lower band (of the regulation rifle) and the projection of the stock, in front of the lock-plate. The rifle should be grasped *firmly, but* not so tightly as to impart motion to it

POSITION DRILL.

[To face page 62.

from the pulsation of the body. Some, indeed, consider it preferable to poise the rifle upon the points of the first, second, and third fingers of the left hand, allowing it to run back freely towards the shoulder by the recoil; but this plan had better not be adopted in the first instance. In the meanwhile, the fingers of the right hand should be behind the guard; the thumb bent obliquely forward over the "small" of the stock. The shoulders are to be at the half-face; the feet at right angles to each other; the eyes directed steadily at the mark; the head *not* inclined forward or against the stock, but kept perfectly perpendicular.

The next movement (at the word—"*Present*" from the instructor) necessitates the throwing the rifle quickly forward, with the full extension of the left arm; both arms moving close to the body, the elbows downwards. The barrel of the rifle will be held nearly horizontally, the muzzle being slightly depressed. The uppermost side of the heel-plate should be a little below the outline of the shoulder. The trigger-finger is to be stretched along the outside of the guard.

At the word—"*two,*" the rifle will be pressed smartly, with the left hand against the hollow of the shoulder, the left elbow at the same time being brought under the rifle, the right elbow, slightly advanced, nearly square with the right shoulder. The body and head are to be kept perfectly perpendicular the whole time.

At the word—"*three,*" the rifle is to be brought smartly to the capping position, the attitude of the limb and body remaining unchanged; the trigger-finger will, however, be slipped behind the guard.

These several movements will then be repeated while in the act of kneeling.

The right foot will be carried twelve inches to the rear, the toe of the boot touching the ground (as far

to the left of the left heel as will bring the right knee of the *front-rank* six inches to the right when on the ground, and that of the rear rank twelve inches to the right), the foot to be nearly perpendicular, the left leg straight, the weight of the body resting firmly on the right heel.

At the word "*two*"—when kneeling, the left elbow supporting the rifle, will be rested upon the left knee.

The two first motions of the second practice of the position drill are similar in every respect to those of the first practice, except that now, the head is bent slightly forward and to the right; the left eye closed, the right, directed to the bull's-eye or other mark, through the notch of the back-sight.

At the word "*two*," the forefinger will be inserted into the trigger-guard, and bent till the middle of the finger rests on the curve of the trigger. A moderately deep inhalation will now be drawn, and the lungs must be kept inflated, the breathing being entirely restrained till the trigger is pulled.

Steadily and deliberately raise the muzzle till the extreme point of the foresight, covering the centre of the object, is perfectly in a line with it, and with the notch of the back-sight.

At the precise instant when the pupil feels assured that the line is true, and without the delay of a second, he must *pinch* or press the trigger steadily and without any jerk; carefully, at the same time, retaining the rifle in its position and keeping his eye still directed upon the object.

The rifle is then brought to the capping position, and the process is repeated.

The engraving on the opposite page represents all the different attitudes above described.

The third practice, whether standing or kneeling,

POSITION DRILL—KNEELING.

[*To face page 63.*

simply combines the "loading" according to the platoon exercise, with the motions already described.

When an instructor is present, it is his duty more especially to see that the sights are always kept in an upright position, that the rifle is held steadily against the hollow of the shoulder, that no jerk accompanies the pull of the trigger—the forefinger deriving no aid from the hand or arm—and that the fall of the hammer produces no deflection of the muzzle. The pupil will find it advantageous when alone to go successively through the whole of the motions of the position drill with a penny piece, or disc of lead about that shape and size, balanced upon the barrel about an inch nearer to him than the muzzle sight. When he can accomplish each movement, including the pull of the trigger, without displacing the penny piece, he will have quite as satisfactory an assurance as the word of an instructor, that he is tolerably perfect in his preliminary lesson.

It will probably be some little time yet ere he can break himself of an involuntary tendency to wink the right eye as the hammer descends; but he must persevère, nevertheless, as it is useless to proceed further till he has mastered that difficulty. He may then, with the same object, begin snapping caps, invariably, however, having regard to aim always at some object whenever he pulls the trigger, and when aiming even for that purpose only, to take precisely the same precautions in every respect that he would take, were he firing ball cartridge.

The reader will have observed, that each progressive step hitherto enumerated, may be learnt as readily in a room as in the open air; and be his avocations what they may, if he keep an old rifle within reach, he will soon familiarize himself with the proper mode of handling it and of taking aim with it, if he occasionally,

two or three times a day, performs the different exercises above described.

The explosion of a military cap has sufficient strength to blow out a candle placed four or five feet from the muzzle; if the barrel be held true and the muzzle-sight be made to cover the upper part of the burning wick.

Considerable proficiency in aiming may consequently be acquired by the expenditure of fifty or one hundred caps, under circumstances where rifle range is not to be had, and ball-practice is consequently impracticable. Even when no difficulty exists upon that point, it will be advisable, before expending an ounce of lead, to practice for a few days the whole of the position drill, using blank cartridge only. For this purpose, the regulation blank ammunition, now manufactured at Woolwich, is exceedingly well adapted; for each cartridge contains a mock bullet which is torn off and rammed down precisely in the same manner as its leaden prototype, so that the practice being invariably the same under all circumstances, the soldier is less likely to blunder when loading on actual service. The mock bullet alluded to is composed of powder, enveloped in a thin muslin tissue, through which it is easily ignited.

The pupil will perceive before he has fired many cartridges, that there is a slight, but very perceptible, "kick" of the rifle, caused by its recoil; he will also however find, that the more steadily the piece is held, the more trivial is the kick.

CHAPTER IV.

Target practice—Description of targets—Site—Butt—Faggot butt—Signal flags—Practice of recruits—How recorded—General system—Adopted from the French—Extract from Captain V. A. King's account of his proceedings at Hythe—Proficiency of the Volunteers greater than that of the regulars.

The learner will by this time probably be desirous of testing at the butt, the amount of benefit he has derived from the foregoing instructions. He already possesses some theoretical knowledge of the laws of projectiles, of the principles of the rifle, of the proper mode of handling that weapon while taking aim; but we will suppose, that he has never yet fired even one ball-cartridge.

In the course of last summer, about fifty officers made their appearance at Hythe, for the purpose of going through the regular course of musketry instruction. Thirty of them had had no previous instruction whatever in rifle-shooting. To each of these, three ball-cartridges were handed, with a request that they should fire at a target 8 ft. by 6 at a range of 600 yards. Out of the 90 shots, 18 hits only were made. After they had gone through one course only of the ordinary preliminary drill, the same officers, under similar circumstances, made 30 hits, showing that their efficiency had been nearly doubled by the lessons they had received.

In every instance, where a similar test has been

applied, the like results have been noted. The pupil may therefore be assured, as he takes his stand for the first time before a target, with a loaded rifle in his hand, that he is far better qualified for the duties he is about to commence than nine-tenths of those, who without method or system, have ineffectually expended many hundred-weight of lead in fruitless attempts to become marksmen.

For the first few rounds, the distance should not exceed 40 or 50 yards, and although I have always laid it down as an invariable rule, that no alteration should ever be allowed in the charge of powder to be used with a particular arm, still, for the mere purpose of gradually accustoming the shoulder to the recoil, the first half-dozen cartridges need not contain more than a drachm of powder each.

The practice-target universally adopted throughout the service—for ranges from 150 to 300 yards—is a cast-iron slab, 6 ft. high and 2 ft. broad, sufficiently strong to resist the blow from the heaviest rifle-bullet at any range. Its surface is divided into twenty-four equal squares to facilitate marking off the hits on the register.* In the centre is an 8-inch disc, surrounded by a circle 2 feet in diameter. The target itself is whitewashed, the bull's-eye and circle being alone coloured black.

For ranges from 400 to 600 yards, the whole of the interior of the 2-foot circle is coloured black.

At Hythe, the practice at ranges from 650 to 900 yards is at a much larger target, having a black bull's-eye, 3 feet in diameter.

Up to 300 yards, the practice is performed standing; beyond that range, kneeling.

* These "RIFLE TARGET REGISTERS" are sold in books containing a quarter of a hundred each, by Messrs. Routledge, 2, Farringdon-street, E.C.

The target should be securely bedded upon a balk of oak, about three times the width of the target, and this piece of timber should lie directly at right angles to the line of fire. When selection is possible, a practice-ground should be chosen, running north and south, the target being fixed at the northern extremity. It will thus always be in a full light, and the shooter will have the sun at his back. The next best site for the butt, is at the eastern extremity of the ground. Great care should be observed in marking out any private rifle-grounds, that a sufficient mound or wall or embankment be provided at the rear and sides of the target. Where economy is an object, a stack of faggots, twenty-four feet thick, will be found much less expensive and nearly as effectual, if properly constructed. It should not rise less than twenty-five feet above the butt, and should flank it for thirty or forty feet on either side. While it is being built, if a layer of clay be interposed between each stratum of faggots, it will add much to its solidity and impermeability.

If the whole be thatched at top in the usual way, it will last many years, and when taken down, the faggots will be worth nearly as much as at first, for fire-wood, while a very large proportion of the lead that has missed the target will be recovered. At Hythe, large embankments of shingle and sand, about fifteen feet high, are thrown up to arrest any stray bullets, and these mounds will, in process of time, be converted into rich mines of lead. For the protection of the markers, a trench is dug about forty-five feet in front, and about five yards to the right or left of the butt. Equally good protection, however, is afforded at less expense by a circular iron-plated sentry box, with one small aperture commanding the target, and another at the opposite side, for enabling the inmate to hoist

one of the four signal flags* provided for that purpose.

A red flag is the "danger" signal; this is exhibited whenever it is requisite to cease firing for the purpose of re-colouring the targets, &c. No one is allowed to leave the marker's butt, until the *cease fire* has been sounded, or the danger flag raised at the firing point, in answer to the danger signal. The "cease fire," whenever sounded from the firing point, is answered by hoisting the danger flag from the marker's butt, and the "commence firing" by lowering it.

I will now proceed to describe the mode in which the practice is conducted, and the skill of each man unerringly recorded. A fatigue party of (not less than) six men, in charge of a non-commissioned officer, and placed under the orders of the instructor of musketry, is daily told off for the different duties on the practice-ground. Their functions, amongst others, include fixing and cleansing the targets, assisting to signal shots, and they have also to warn all persons from venturing across the line of fire.

* The shots that strike the target are denoted by flags of different colours. These flags, together with the number of points indicating the value of the shots, are as follows:—

	Shots.	Flags.	Value in points.
In the practices to 300 yards inclusive.	Outer	White or yellow	1
	Centre	Dark blue	2
	Bull's-eye	Red and white	3
	Ricochet	Red flag waved in front of the butt	R
	Miss		0
In the practices at distances beyond 300 yards.	Outer	White or yellow	1
	Centre	Dark blue	2
	Ricochet	Red flag waved in front of the butt	R
	Miss		0

Shots which strike the ground or "ricochet" before hitting the target, are indicated by waving the red flag twice, and are not counted in individual firing, but are noted in the register by the [illegible] R.

It is a bright clear spring morning, there is hardly any wind, and the 8-inch bull's-eye is distinctly visible upon the 6-foot target, at a far greater range than it will be fired at to-day.

Four sections, each consisting of sixteen recruits, none of whom have ever yet fired more than a few blank cartridges, are wending their way across the shingle, to the spot allotted for their intended trial; an officer-instructor and the serjeant-instructor, who has had the drilling of the different squads, accompanies his own section. It is an anxious time for the serjeants, as they are to a certain extent held responsible for the proficiency of their men, whose skill is considered to be so entirely dependent on the drill they have undergone, that if they do not acquit themselves creditably, the unfortunate instructor is requited with a mark to that effect, which stands recorded against his name.

Each serjeant has in his hand, a ruled blank register, as yet containing only the names of the men in his section, arranged as they will presently stand in the ranks for firing, and so contrived that it will serve to exhibit the performances of the squad at two different distances. As each shot is fired, it is the duty of the instructor to enter immediately in ink opposite to the name of the man who fired, either 1, 2, 3, R, or 0, according to the prescribed value of the shot.

We will note the proceedings of No. 1 Section, as it takes up its position "two deep" at the appointed spot, 150 yards from a target. The eagerly anticipated command — "*With ball cartridge — load*" — is given in a deep sonorous voice. Each rear rank man, locks up closely to the one in front of him, and all proceed to load. That operation completed, every rifle being at the half-cock, the command "*order arms*" is heard,

followed by "*Stand at ease.*" This is succeeded, as soon as the red flag at the butt is observed to be lowered, by—"*Independent firing from the right flank as a rear rank standing—commence.*" Thereupon No. 1 shoulders arms—advances one pace, takes a half face to the right, bringing his rifle to the position indicated by the word "*ready.*" Selecting his own time, he raises his rifle slowly, and when he conceives that his aim is perfect—fires. No sharp metallic ring re-echoes from the target, the rush of the bullet alone is heard, while a handful of gravel, flung into the air from the mound, shows too plainly where the bullet lies buried, just a couple of yards above the upper rim of iron. The direction was good, which is so far creditable for a beginner, but in all likelihood a jerk was given at the critical moment, which threw up the muzzle, and caused the unsatisfactory entry of a zero, opposite the name of No. 1.

No. 2, follows with better success; his eye has been steadier, and his aim more sure. A dark blue flag exhibited against the sky-line, above the butt, proclaims that he has struck the centre, and that his shot counts 2. Nos. 3 and 4 each gain one point only. No. 5 makes a bull's-eye, and triumphantly scores 3. Nos. 7 and 8 respectively score 2. The countenance of the serjeant, hitherto somewhat gloomy, brightens up a little as the red and white flag announces that No. 8 has made a bull's-eye, but alas! no bunting whatever appears responsive to No. 9's discharge; his bullet probably was not rammed home, for the recoil was evidently great, and has nearly sent him to the right-about. No. 10 gains 1 point; No. 11, 2; No. 12, 2; Nos. 13, and 14, each 1, and 15 and 16 each 2. The total number of points attained by the section will therefore be 25,

proving that the instructions the men had previously received have not been thrown away.

At present, they are all in the third class, and before they can hope for preferment they must each fire 19 more shots, that is to say, 4 more at 150 yards, then five rounds per man at 200, 5 at 250, and 5 at 300. Fifteen points gained during these 20 shots, entitle the fortunate marksman to rise into the second class. The distances in the second class are 400, 500, 550, and 600 yards. Five rounds are fired at each range. Should a man be skilful enough to obtain 12 points in the course of this ordeal, he is entitled to rank in the first class. If he cannot gain 12 points the first time, he must re-commence.

The distances at which the first-class men have to contend are 650, 700, 800 and 900 yards, at each of which, 5 rounds are fired. He who gains 7 points under these circumstances is proclaimed a marksman.

Of the 8 files above alluded to, 9 men have exceeded the prescribed number of marks, 3 have gained 14, while the remaining 4 have only scored 11, 9, 10, and 10.

At the close of the practice, at each different distance, the bugler sounds the "*cease fire*" and the "*assembly*," whereupon the officer in command of the section and the musketry instructor proceed to the target, together with the whole of the men. In the presence of the marker, they then compare the face of the target with the results already recorded upon the register, adding to, or deducting from, the "total points," according as any error may be found to require such alteration. When finally corrected, the total number of points is divided by the number of men in the section, the quotient being carried to two places of decimals in order to determine the average

merit of each man. The average number of merit of [illegible] of recruits, whose practice has just been [illegible] was accordingly 1·56. By this simple test, the [illegible] of every man is known, and recorded [illegible] at any future time.

The register is now signed by the marker, and by the musketry instructor, and countersigned by the [illegible] of the company: after which, the "duplicate [illegible] points" bearing the initials of the officer instructor [illegible] its agreement with the column of [illegible] is torn off, and handed to the battalion sergeant instructor on the practice-ground.

In the case of recruits, the registers are signed by the [illegible] instructor and marker, and countersigned [illegible] the officer instructor, or his assistant. The "[illegible] points" are not then torn off.

On the return of the company instructor to barracks after every practice, he enters the total number [illegible] points gained by each man, opposite the proper [illegible] of the company, headed "Musketry drill and practice return." The total amount of points obtained by the recruits, are entered in a similar manner [illegible] sergeant instructor.

In the course of this training, every recruit, and [illegible] annual course of practice, every drilled soldier, [illegible] rounds of ball ammunition, in the following manner:—

[illegible] in individual firing,
[illegible] in file firing,
[illegible] in volleys, and
[illegible] in skirmishing or extended order.

[illegible] standing rule is, that no squad or [illegible] is under any circumstances, to fire more than [illegible] rounds or to practise at more than 2 distances in [illegible] day.

[illegible] should fire at one or more distances in

the course of a "period," and from any cause be prevented from completing it with his company or section, he is, nevertheless, considered as having finished such period, and is classed according to the number of points he has already gained. These points are included in the total number of the company, and are taken into account in computing the average merit of its shooting in the "period."

When, from sudden illness, a man is prevented from completing his practice at any one range, he is considered as not having fired at all, at that particular distance.

Such, then, are briefly the regulations of the target practice as originally instituted at the *Ecoles de Tir*, at Vincennes, Grenoble, St. Omer, and Toulouse, and adopted, in 1853, with but few unimportant modifications, in this country. In the establishment of our schools of musketry indeed, we can claim little more than the merit of having—perhaps somewhat tardily—adopted a system, the importance of which had long been recognised on the Continent of Europe, and has now for some years past, been acted upon in America.

The following extracts are from the account of recent proceedings at Hythe, written by a Volunteer (Captain V. A. King, of the 2nd Cheshire Rifles). His narrative is so apposite to the subject now under consideration as to merit—in the abridged form in which it is now given—introduction here. It elucidates what has been already stated, and shows at the same time, upon the testimony of another eye-witness, the nature of the duties which will devolve upon those who may succeed in obtaining permission to go through the regular course of instruction at Hythe.

"On Monday, the 25th of July, we assembled," says Captain King, "in the barrack tent—a rifle,

knee-cap, and book of instructions were delivered to each. We were then formed into six sections, containing from six to nine men respectively, and were ushered into the lecture-room to hear a few words from General Hay. He told us he was a warm friend to the volunteer movement, which he would do all in his power to promote, as he considered it essential to the safety of the country. He thanked us for our zeal in coming so far for instruction, and stated that it would give both him and his staff the greatest pleasure to impart to us all they could, in the very limited time we had for the course. He then stated that if the volunteer force could not shoot—they were worse than useless; for 'suppose,' said he, 'there are 200,000 Volunteers enrolled, that Government depended on them, but that when the hour of trial came, it turned out that none of them could shoot, it must be clear we had much better not have a volunteer force at all; for, if they could not shoot, we should be hanging on a rope of sand. Much better to have even 2000 men who can shoot, than 200,000 men who cannot.' He ridiculed the popular error which has been so much dwelt upon in the newspapers, that nothing but plenty of ball practice will ever make men good shots. He told us that such practice only perpetuated error, that he could bring forward many instances where men shot worse and worse by *mere* practice. He then said that it was position drill *alone* which could teach us to shoot; the more of this a man had, the better. In fact a man had never had too much position drill until he had not a single fault.

"The first object of this position drill is to teach men to shoot without ever firing a shot; and I am certain that this can be done. He told us that we Volunteers ought to be such good shots that their fire would be effective at 600 to 900 yards; adding that it was an

extraordinary fact, that the riflemen of the British army, until the last few years, shot worse than any other troops. He told us that the great object of the instructions at Hythe was to raise the intelligence of the soldier, to make him consider himself an unit, and not a machine.

"Our daily work for the first week, was confined to cleaning arms, studying theoretical principles, aiming drills, position drills, judging distance drills. In the cleaning of arms we were not only taught to clean our rifles, but every part of the weapon was named and explained to us. We were taught to dismount and remount the lock, and name every part of it. The lectures on theoretical principles explained clearly the force which impels the bullet forward, the force which retards its flight, the force which draws it to the ground. The course of the bullet through the air was clearly described, together with the reason for our having to take a great elevation when firing at a very distant object.

"We were taught always to aim at an object, and never to pinch the trigger until we had aligned the eye, the object, the back sight, and the fore sight. The greatest pains were taken in the position drill, as it is the foundation of good shooting. In judging distance drills, we were marched out to the shingle, where points were placed at different distances for us to observe, and we then had to judge the distance of men placed at various distances. Many of us were at the barrack-yard at 6.30 a.m. for an extra drill. We assembled at 9.30 a.m. and worked till 1 p.m.; then assembled at 2.30 p.m., and worked till 4.30 p.m.; then each section went to the quarters of one of them, and discussed and questioned each other on all they had heard during the day; work was over at 7 p.m., when we dined. On the 1st of August, we

fired blank cartridge, and the next day we began firing ball, and then commenced such excitement as I never before witnessed. The first course was the third class. We fired five rounds at 150 yards, five at 200 yards, five at 250 yards, and five at 300 yards; and those who did not make 15 points were kept in the third class. Our gallant lieutenant made 29 points; another man, Warner, of Oxford, made the same; and this was the largest score. I only made 14 points, but am now a second-class man. Lieutenant Horner is a first-class man, and Ensign Bower, of the Rockferry Company, has the honour of being a marksman.

"The second class was contested for by 5 rounds at 400 yards, 5 at 500 yards, 5 at 550 yards, and 5 at 600 yards. It was necessary to make 12 points out of these to get into the first class, and 17 of our whole number (42) remained in the second class. To attain the first class, we had to fire 5 rounds at 650 yards, 5 at 700 yards, 5 at 800 yards, and 5 at 900 yards. It was necessary to make 7 points to become a marksman, and there were no less than 14 who did this. This practice lasted from Tuesday to Saturday, and I cannot describe the excitement it caused. It exceeded anything I ever saw. Hunting, or cricket, or boating, is nothing to it. I felt, when I saw it, that there was no mistake about the volunteer movement. We subscribed for 3 rifles—one for the best shot of the whole; one for the best shot of the right wing; one for the best shot of the left wing. Warner, of Oxford, won the first; Robert Tinley, of Liverpool, the second; Coxe, of Derby, the third. Great, indeed, was the excitement on Saturday afternoon. The struggle was between Warner and Tinley for the first prize; they were firing at 900 yards. There were many spectators; and as each of these two men knelt to fire, there was not even a whisper heard; all seemed

afraid even to breathe. They both got 11 points—a tie; but Warner won, as in the previous classes he had made 53 points, and Tinley 51. Tinley had, unfortunately, twice aimed at the wrong target, and hit it, and these two points did not count, otherwise Warner and Tinley would have been ties throughout. On Monday we fired ten rounds file firing, ten rounds volley firing, and ten rounds skirmishing. The last is beautiful work. We loaded as we ran, and fired at distances of 400 to 200 yards; but we had to judge our own distances, and we were kept advancing and retiring as much as possible, so as to confuse us. If at 200 yards distance we fired at an elevation of 400 yards, our bullets would go at least 5 feet above the target. At a range of 400 yards, had we fired at an elevation of 200 yards, then the bullet would have struck the ground at 280 yards. Now for the result of our ball practice.

"Every shot fired at Hythe is registered. If a man fire badly or carelessly he is sure to be found out. All is reduced to figures. There cannot be a question about who shot best and who worst. The shooting is estimated by figures, which cannot err. I will now give the figures of merit of each section. No. 2 Section stands first—namely, first period, 22·00; file firing, 11·66; volley firing, 12·00; skirmishing, 5·00; total, 50·66. No 4 Section—First period, 20·66; file firing, 11·55; volley firing, 9·55; skirmishing, 7·88; total, 49·64. No. 5 Section—First period, 18·00; file firing, 13·28; volley firing, 11·71; skirmishing, 7·88; total, 48·82. No 6 Section—First period, 21·14; file firing, 10·10; volley firing, 11·33; skirmishing, 5·33; total, 47·96. No 1 Section—First period, 18·14; file firing, 13·00; volley firing, 9·16; skirmishing, 3·83; total, 44·13. No. 3 Section—First period, 17·00; file firing, 12·66; volley

firing, 8·00; skirmishing, 3·66; total, 41·32. And the mean average figure of merit of the battalion was as follows, namely:—Single Third Class, 19·36; file firing, 12·08; volley firing, 10·13; skirmishing, 5·50; total, 47·87. Which means that out of 50 rounds each man on an average had made 47·07 points. Some, of course, had not done so well, and others had done much better. I will now give the comparison with officers and soldiers who had passed through the previous three courses at Hythe. It will naturally be presumed that we Volunteers were, of course, far behind them; for they had had 16 position drills—we had only six; they had had a preliminary course of 20 rounds of ball cartridge—we had not had any, but fired at once in the third class. The mean averages are as follows:—1859, January—officers, 46·08; soldiers, 43·97. April—officers, 46·94; soldiers, 44·35. July—officers, 45·62; soldiers, 42·62. The mean of this being—officers, 46·22; soldiers, 43·65. General Hay was surprised at this result: he said he expected us to beat the soldiers, because, in shooting, intelligence is what tells, but he could not understand our beating the officers. He could only account for it by the fact that we had worked so much harder than the others."

Nothing, indeed, can show better than this simple fact, the zeal, intelligence, and skill of the class of men who are daily swelling the ranks of the various volunteer regiments over the country. Efficiency is the object they all have in view, and as it has now been proved that they can easily excel ordinary troops—whether officers, or rank and file—in rifle-shooting, there can be but little doubt that they will in a few months fully equal them in the precision with which they will perform the principal battalion movements they will have to execute.

Every pupil at Hythe, whether officer or recruit, has

moreover during the course of his instruction there, to fire 5 rounds *singly*—at 100, 150, 200, and 250 yards, at two targets, standing; one round at each distance to be fired from a rest. The result of each shot thus fired is recorded in a register, and the total number of points obtained at each distance by each individual are entered opposite to his name in the return kept of the musketry and drill practice of each recruit.

In this *individual firing*, as it is termed, each pupil practises at every 50 yards from 150 to 300. When the section has completed this "period," the number of points individually obtained, are added up, the amount being entered in the column headed "total points" of the period in the "Musketry drill and practice return" to show the relative merit of each man; from this column a classification is made;—all who have obtained 15 points and upwards, passing into the second class, while those who have not obtained this number are formed into a third class.

The names of those pupils who have passed into the second class, and the number of points they have each obtained, are read over by the captain, or officer commanding, to the company on parade, before the "second period" is commenced.

In the second period of individual firing, the section or company practises in two classes, viz., second and third. In the practice of the second class, the centre is painted black, and the points allowed to reckon for a bull's-eye are discontinued. At the conclusion of the whole of the practices in this period, the points obtained by each man at the several distances, are added together, and the sum entered in the columns "total points," from which a second classification is made, when all men of the second class who have obtained twelve points and upwards, pass into the first class;

and all those in the third class who have obtained 15 points and upwards, into the second class. Those who have not succeeded in obtaining the number of points specified, remain in the second and third classes respectively. In the case of troops armed with rifles or carbines sighted only up to 300 yards, the second class, during this period, repeat the practice of the third class, firing however at a single target, 6 feet by 2 feet, at every distance, and those who obtain 14 points and upwards, pass into the first class.

In the third period of individual firing the section or company practise in three separate classes.

In the practice of the first class the bull's-eye is increased to 3 feet in diameter, and coloured black; all shots hitting it counting as two.

At the conclusion of the practices in this period, the points obtained by each man are added together, and their sum is entered in the columns "total points," from which a final classification is made.

The company-instructor then makes out a final classification, in which the men are entered in order as to merit, having affixed to their names the number of points obtained in each period of individual firing.

All who have succeeded in obtaining seven points and upwards, in the first class, are exempted from aiming drill at distances under 600 yards, in the succeeding annual course of musketry instruction.

Ten rounds of ball ammunition are expended by each recruit, as well as by the drilled soldiers of every company annually, in file firing at 300 yards. The mark for this practice, and also for volley firing, consists of eight targets placed close together, each having a separate bull's-eye and centre of the dimensions detailed for the third class. Every hit in this practice has the same value in points, as those in the third class.

The strength of the section firing, in this and the following exercise never exceeds ten files.

Ten rounds of ball ammunition are expended by the recruit, as well as by the drilled soldiers of every company annually, at 400 yards, both ranks kneeling. The hits are counted as in the second class, bull's-eyes being reckoned only as centres; and in this, and the skirmishing practice, care is taken that the men of the third class, who have not fired beyond 300 yards, adjust their sights to the proper elevation.

Ten rounds of ball ammunition are expended by the recruit, and also by the drilled soldiers of every company annually, in skirmishing order, advancing and retiring between 400 and 200 yards, each man judging his own distance, and arranging his sight accordingly. Eight targets, each having its bull's-eye and centre of the dimensions detailed for the third class, are arranged with intervals of six paces between them. Every file has its own target, and the hits are counted as in volley firing; bull's-eyes being only valued as centres. In firing, when advancing, the men may fire kneeling—rising to load,—which they may do at the halt, running up to the file leaders, after returning their ramrods, and capping, after giving the word "ready."

A sentry (one of the fatigue party) is placed on each flank of the extended targets, about 40 or 50 yards off, to prevent any person approaching within that distance.

At the conclusion of the firing of each squad or section in this practice, as well as by files and in volleys, the company-instructor, and a non-commissioned officer of another company, go up to the targets and mark off the hits upon a diagram, to which they affix their names as soon as it is completed, in proof of its correctness, which is further confirmed by the signature of

the captain or officer of the company, whose duty it is to witness both the practice and the examination of the targets.

The diagrams of the performances of each squad or section, as soon as completed, are handed over to the officer-instructor, or battalion sergeant-instructor, the company-instructor taking a memorandum of the points obtained by each section, to be inserted in the columns set apart for the purpose, in the "Musketry drill and practice return."

All the pupils who remain in the third class at the final classification, are exercised, after the yearly course of practice is concluded, through a course of aiming and position drills, snapping caps, and blank firing, in every respect as recruits; and afterwards to fire through the "first period." Those who obtain fifteen points are not exercised any further; those, however, who do not, are again put through the course of drill just specified. The performances of such men are entered in a recruit's practice return, set apart for the purpose, and headed "Third class shots at final classification."

The average points obtained in the "skirmishing practice," added to the averages obtained in the "first period," and in the practices of "file and volley firing," denote the "*merit*" of the shooting of the section or company.

No one is ever allowed to be exercised in any of the practices by files, volleys, or skirmishing, who has not completed a period of individual firing; nor is any one allowed to practise in the "third period" until he has been exercised in the "first and second periods" respectively.

The following table exhibits the different practices, in those cases where the available range does not *extend to* 900 yards:—

When the ranges only extend to	Practices to be performed. 1st period.	2nd period.	3rd period.	File firing.	Volley firing.	Skirmishing.	Total number of rounds to be fired.	Remarks.
308 yards	1	1	–	1	1	1	70	The second class to repeat the practice of the third class; firing at a single target. Volleys to be fired at 300 yards standing, and skirmishing between 300 and 200 yards.
400 „	1	1	–	1	1	1	70	The second class to fire ten rounds at 350 and ten at 400 yards,—one distance a-day.
450 „	1	1	–	1	1	1	70	The second class to fire five rounds at 350, five at 400, and ten at 450 yards; but not more than ten rounds a-day.
500 „	1	1	–	1	1.	1	70	The second class to fire five rounds at 400, five at 450, and ten at 500 yards; but not more than ten rounds a-day.
550 „	1	1	*	1	1	1	*70	The second class to fire five rounds at 400, five at 500, and ten at 550 yards; but not more than ten rounds a-day. * Should a range of the full extent become available, the third period to be executed in this instance only, and 90 rounds expended.
600, and under 900 yards.	1	1	1	1	1	1	90	The first-class men are not to fire at any distance until an opportunity of a range to 900 yards offers.

Troops provided with arms, sighted only to 600 yards omit the third period, and expend 90 rounds in the training of recruits, but only 70 in the yearly course of practice.

It now becomes necessary to consider the subject of ammunition, and the mode of preparing it.

As the pupil finds by daily practice, that his skill

increases, and that he is able to show, after an hour's target shooting, a creditable diagram, he naturally feels a disposition gradually to extend his range. Indeed, at the end of about three months, he will, with moderate industry and diligence, experience little more difficulty in striking a 3-foot bull's-eye at 500 yards, than he did, in the first instance, in hitting one 8 inches in diameter at 150 yards.

The greater the range, however, the greater at the same time must be the attention given to steadiness of aim, to the care bestowed in loading, to the fit of the bullet and its lubrication, to the charge of powder, no less than to its quality. We will therefore proceed to discuss these several topics *seriatim*.

The bullets prepared for the use of soldiers in the English service are all now made, as is well known, by compression, a process requiring a considerable amount of expensive machinery, and therefore not practicable for the majority of volunteer riflemen. A very perfect bullet is the result of the above operation; all are precisely similar in size, weight, and density, while there is a total absence of those "faults," flaws, or cavities that are always to be found in cast bullets.

The saving of time, too, is very great. The machine* at the arsenal at Woolwich will, with very little supervision, turn out 2650 bullets in less than two hours, at a cost of 16*s*. per 1000 (rather more than one penny for every five). To cast the same quantity would occupy two men and a boy ten hours, the price of these far less perfect bullets being, under these circumstances, 18*s*. 4*d*. per 1000.

Before commencing the manufacture, the greatest care is taken to ensure the purity of the material

* This machine, with the requisite supplementary apparatus, cost 2400*l*. For further information on this subject the reader is referred to Captain Hawes' elaborate work on Rifle Ammunition.

used. For this purpose, portions weighing about 200 grains, are selected from each of the pigs, that weigh about 1 cwt. each. These samples are tested with a view to detect the presence of antimony, copper, arsenic, iron, or tin. Should there be no valid ground for rejection, the pigs are carried to what is called the lead-squirting machine,* having previously been dropped into one of a series of melting pots, in which the metal is first reduced to a semi-fluid state, and then pressed into the form of rods, which as they issue from the press, are coiled away—in lengths of about 130 yards—upon reels ready for use. Each coil thus made, weighs rather less than a quarter of a ton, and will suffice for 6800 regulation bullets.

A couple of these machines, each attended by three men, are kept constantly at work at Woolwich, to maintain a sufficient supply of the massive coils for the bullet machine. Before entering the next stage of their transformation, they are unwound from their original reels: the end of one coil is passed between a pair of grooved rollers by which it is drawn forward, through a box containing a lubricating composition, to facilitate its subsequent movements. Passing through a hole rather more than half an inch in diameter in a moveable lever, a piece of lead, of exactly the length of the future bullet, is cut off. Instantly seized by a pair of nippers, the little cylinder is held momentarily before a die, precisely of the shape and dimensions of the Enfield bullet; a punch is suddenly protruded, forces the cylinder into its destined receptacle, where it is made to take the prescribed form, and is marked both on the sides and base, with the broad arrow, proclaiming to all whom it may concern, that the diminutive but formidable

* One of these machines, with hydraulic press, &c., capable of working up to 800 or 900 tons, costs about 1250*l*.

missile before them, is the exclusive property of Her Majesty.

But it is not yet perfected for its mission of death; it has still to be driven through a steel plate, in order to be deprived of a film of lead that adheres to its base, and at the same time to be gauged. In bright and rapid flow, a continuous stream of newly-made bullets passes through a trough, into which they drop incessantly during the hours that the machine is at work, at the rate of between 1800 and 2000 per hour.

In my work, "THE RIFLE, AND HOW TO USE IT," I have already given full directions on the subject of casting bullets: if duly attended to, those instructions will be found ample for all purposes, unless a very large quantity be required. It will then be advisable, in addition to the small ladle for filling the mould, to have, instead of a larger ladle for the fire, an iron kettle capable of containing from thirty to fifty pounds of lead. This kettle should be maintained as nearly as possible at the same temperature, and the supply of lead in it, should be constantly kept up to within about 3 inches of the brim. To prevent the lead from oxidizing, after it has been cleaned by dropping a small piece of tallow into it, and removing the scum or film that had previously formed, it is advisable to keep the surface covered with a layer of coarsely powdered charcoal, about an inch thick, which can easily be prevented from falling into the dipping ladle by means of a chisel-shaped piece of hard wood. The lead should only be poured into the moulds when it is sufficiently hot to light a paper match dipped into it. There is no advantage whatever in smoking the inside of the mould, it ought, on the contrary, to be kept clean and bright, and never allowed to get too hot.

The American plan of "swedging" cast bullets is

an admirable one, as by that means most of the imperfections of cast bullets are rectified, an equal degree of density and solidity being given to them throughout. There are various contrivances for this purpose. A simple plan is to have a hollow, highly polished steel die accurately made, of the precise shape and dimensions of the perfect bullet, into which those that have been cast, are to be dropped; a solid plug of hard steel, fits accurately, the interior of the base of the swedge, and a few smart blows from a light hammer upon this plug, suffice to close up any internal air-bubbles in the bullet, and to give at the same time to its surface as high a polish as that of the mould.

Major Nuthall has patented a very elegant and ingenious instrument of this kind, the best yet produced. It is very compact, and will lie in a corner of the gun-case. It accomplishes the purpose for which it is intended by means of 2 or 3 turns from a small winch-handle, gauging every bullet passed through it, to less than the thousandth of an inch.

The result of hundreds of thousands of experiments at Hythe and elsewhere proves, as Colonel Wilford assures us, that "the auxiliary to expansion, derived from the wooden plug, gives vastly increased accuracy at long ranges, when compared with the Pritchett bullet." This remark, of course, applies only to the Enfield bullet, for both upon Jacob's and Whitworth's principles, the annihilation or reduction to a minimum of windage, being attained, as previously observed, by mechanical fit, any adventitious aid like that derivable from the plug, is, with either of these rifles, wholly superfluous.

General Hay it was, who proposed the substitution of a box-wood plug of conoidal form, for the small iron-cup, and there is no doubt but that it fully answers the purpose intended by its ingenious

inventor, and that its utility is plainly manifest at all ranges beyond 700 or 800. These plugs are formed in a machine, of the character of a lathe, of rather complicated aspect, which turns them out at the rate of 10,000 a-day, at the cost of about 1*d*. per 100.

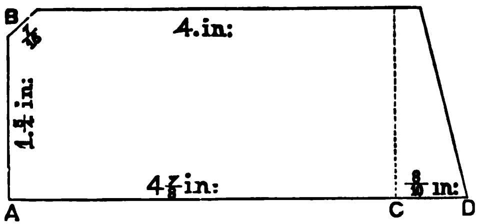
Before being fitted into the bullet, they are coated by immersion, with a thin film of wax. Each bullet before being plugged is examined, and if any defect appear, it is rejected. If not, the plug is pushed evenly into the cavity at its base. The bullets are now gauged by means of a ring, one thousandth of an inch larger than the bullet. They are then arranged in trays, so that the apex of each, alone is visible; should the slightest defect be perceptible in any one, that bullet is summarily rejected. The rest are removed to another room to be made up into cartridges. As this manufacture very properly constitutes an important part of the course of instruction taught at Hythe, I will describe the process.

The paper principally used, is that known as "White fine," the size of the sheets is 29 in. by 19$\frac{5}{8}$, the reams weigh 13 lbs., and the price is about 1*l*. 6*s*. A few sheets from each ream, are examined as to toughness, regularity of texture, smoothness of surface. The external covering of each cartridge is of a stouter quality. These sheets are 25 in. by 19 in. The reams weigh 45 lbs. and cost 1*l*. 5*s*. 6*d*. each. The twine for tying the cartridges is that known as "3-ply," and costs about 1*s*. 8*d*. per lb.

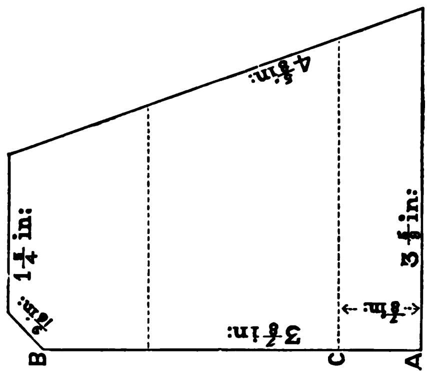
Great care must be taken that, whatever the paper used, it may not increase the diameter of the bullet, when the cartridge is completed, more than 9 thousandths of an inch.

The implements requisite are three tin patterns of he shape and dimensions shown in the woodcuts opposite, and, in addition, a former, represented in the margin :—

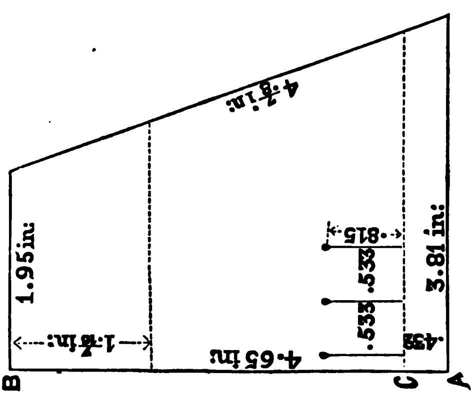
STIFF PAPER.

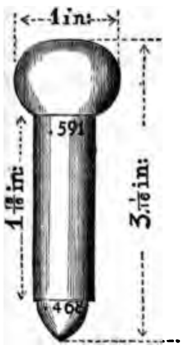


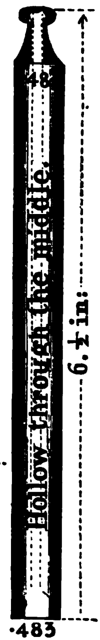
INNER ENVELOPE.



OUTER PATTERN.







A plug, a pair of strong scissors, knife, piece of cat-gut, choking pin, fixed to the table, a tray for the bullets, a box for the finished cartridges, a steel gauge through which each cartridge should pass easily.

Having cut the paper according to the size and patterns shown at the preceding page, for cartridges for the long or short rifles, the next step is to

Form the powder-case.—For this purpose roll the stiff paper, pattern No. 1, tightly about 2½ times round the "former" or "mandrel" which is to be laid on the side opposite the acute angle, or A, B, with its base coincident with the broader side, or A, D; then place the "inner envelope" paper, pattern No. 2, on the top of the stiff paper, with the side opposite the acute angle, or A,B, of the former about ¾ of an inch from the acute angle, or CD of the latter, and roll said envelope tightly on the stiff paper and mandrel; after which slightly twist the end that overlaps about ⅞ of an inch, or A,C, and fold it into the hollow at the base of the mandrel, making use of the point of the "former," to close the folds and adapt the paper to the cavity, which is to receive the point of the bullet, being careful to secure the bottom of the powder-case, so that no powder can escape therefrom.

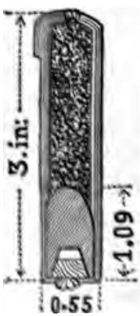
2. *Unite the bullet with the powder-case.* Put the point of the bullet well into the cavity of the powder-case, and place both so fixed on the side of "outer envelope" paper, pattern No. 3, opposite the acute angle, or A,B, and about ½ an inch from the broader side, or A,C; roll the "outer envelope" tightly round bullet and powder-case, with the mandrel still in it, then twist or fold the paper that overlaps, and tie it, by means of 2 half hitches, as closely as possible to the base of the bullet; after which, place the base of the cartridge on the table, and withdraw the mandrel with care, by pressing the powder-case with one hand while raising the mandrel with the other, so as not to separate the powder-case from the bullet, both of which must be kept as close as possible to prevent any play or movement at the juncture, which would soon render the cartridge unserviceable.
3. *Charge the powder-case.*—Place a small tin funnel into the mouth of the powder-case and pour 2½ drachms of powder (or a less quantity, according to the arm used) into it; remove the funnel, being careful that none of the powder escapes between the inner and outer envelopes; and secure the charge, by squeezing the tops of the two envelopes close to the stiff paper of the powder-case, and giving them a slight twist with a pressure inwards, lay the ends on the side of the cartridge.

   The three slits, shown in the outer envelope, are made to facilitate its detachment from the bullet when fired.
4. *Lubricate the cartridge.*—The cartridge being completed, dip the base, up to the shoulder of the bullet, in a mixture composed of 11 parts of beeswax and 1 part of petroleum, or mineral oil.

Formerly, a mixture of 5 parts wax and 1 of tallow was used. It was kept at an uniform temperature of

230° Fah. For private use, an ordinary glue-pot will answer perfectly the purpose of the more cumbersome apparatus necessarily employed at Woolwich.

To those who object to the trouble of making up their own ammunition, the information may be of service, that perfectly waterproof cartridges of the exact Government gauge, are purchaseable at Anthony's (37, Broad Street, Birmingham). They are sold in boxes, containing 1000 ball cartridges, for 70*s.*, or 1000 blank for 45*s.*



The figure in the margin, represents the longitudinal section of a regulation cartridge, and shows the relative position of the ball and the powder. Of late, a very ingenious form of blank cartridge has been devised, with a view to obviate the necessity of teaching the soldier to practise a different system of loading at one time, from that which he has to adopt when on actual service.

The old plan was, to bite off the end of the paper bag, to empty the powder down the barrel, and ram the bag itself home upon the charge. With the new blank ammunition, which externally resembles the ball cartridge, the soldier has to go through precisely the same motions, that he would have to perform were he firing in earnest.

The cartridges in question, are made in the form of bags from pulp, one fitting into the other. The inner bag has a hollow at the base, the other is a plain cylinder with a flat base. The part, containing the imitation bullet, is lubricated externally; into the upper part of this case, the mock bullet, formed of powder, encased in a small muslin bag, is inserted at the top, where the leaden bullet would otherwise be.

At the junction—for the sake of distinction—a purple paper band, half an inch wide is pasted. This muslin bullet is twisted off and treated precisely in the same manner as its more deadly prototype.

One great advantage of this kind of blank ammunition is, that owing to the lubrication, the interior of the barrel is not fouled or rendered unfit for subsequent ball practice.

The following table shows the charges, diameters of the bullets, &c., of the principal small arm cartridges now in use.

SMALL ARM CARTRIDGES.

Nature of Cartridges.	Charge.	No. of bullets to a pound.	Diameter of bullet.	Diameter of "former."
	Drachms.		Inches.	Inches.
Blank for all arms . . .	3·50	—	—	·65
Lancaster elliptic rifle . .	2·50	·10	·28	·65
Rifle musket (pattern 1853)	2·50	13·50	·55	·472
„ „ (sea service 1853)	2·50	13·50	·568	·5
Carbine (carbine bore) . .	2·50	20·	·610	·59
Pistol (musket bore) . . .	2·50	14·50	·680	—
„ (carbine „) . . .	2·	20·	·610	—

To obviate the many difficulties on service, arising from the fouling of the barrel after a few discharges, where the ordinary regulation bullet is used, Captain Boxer proposed to reduce the diameter of the bullet. It was at first imagined that the consequent increase of windage from ·001 inches to ·018 inches, would materially affect the propulsive power of the projectile. In fact, that increased facility of loading would be purchased at the expense of range and precision, added to an imminent risk that the bullet would fall forward when the rifle was "secured" or reversed for any purpose. After the subject had been fully discussed by the authorities, it was determined to test practi-

cally the result of the proposed change. To the astonishment of those who, relying upon theory, had loudly maintained a very different issue, the target-practice with the reduced bullet, was found in no respect inferior to what it had previously been. Nor was any greater elevation needed to maintain the same range. Strangely enough, if there were any difference in the trajectories, it was in favour of the reduced bullet. All apprehension as to the facility with which the bullet would slip from its place was proved to be without foundation, nor has there been shown to be less penetration. These facts conclusively demonstrate that the expansive power exercised by the box-wood plug, is sufficient, even where the windage amounts to eighteen hundredths of an inch. In consequence of the obvious advantages of a projectile of diminished diameter, it was, in February, 1859, determined to adopt throughout the service, a bullet ·55 inches in diameter, and 1·09 long, in lieu of the one ·568 in diameter, and 1·05 long; it was also resolved at the same time that for the future, wax alone, should be employed in lubrication. The addition of one twelfth part of petroleum, or mineral oil, as suggested by Major Nuthall, would nevertheless have proved a decided advantage.

CHAPTER V.

Judging distance drill—Holtzapffel's stadium—M. Porro's teleometer—System as detailed by Col. Wilford—Points for observation—Duties of instructors—Mode of recording distances—Measurement of ground—Classification of squads—Preliminary drills—American system—American judging distance drill.

When the aspirant to the title of "marksman" has attained even such a degree of proficiency in his newly acquired art, as will admit of his ranking in the second or even in the first class, he must bear in mind that he has still an important branch of his profession to master. It is not sufficient to be able to strike, with even tolerable certainty, a target stationed at a known distance, in order that the skill then exhibited, may be practically useful; it is absolutely essential that this skill may be available, under circumstances where the judgment alone is to be relied upon, in the estimation of the precise distance of the object to be struck. An error of a few yards in this respect, will render the best rifle valueless in the hour of need, possibly at a conjuncture when a few well-directed shots might tend to decide the fate of a battle. On such occasions, brief indeed is the interval usually available to estimate the distance of a foe, to elevate the sight, to take aim, and to fire. If the rifleman do not therefore possess in an eminent degree, the knack of correctly judging distances, he is of comparatively no use in the field.

That this power is attainable by practice, every day's experience, more especially at Hythe, convincingly proves.

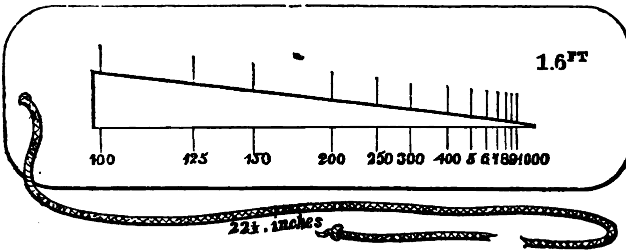
The diagram in the frontispiece shows to what perfection the art may be brought. It gives an exact representation of a target, on which were delineated, of the size of life, one mounted officer, eleven men, and six horses attached to a 9-pounder, in the act of unlimbering.

The firing party numbered 60 men (of these only 23 could be considered as well grounded in the principles of musketry). They opened out in skirmishing order at a distance, unknown to them, of 610 yards, and fired for 2 minutes; at 810 yards a second fire, that lasted for 3 minutes, was delivered. Each man in the front rank fired 3 rounds, those in the rear, 2 only. By the first fire, 37 hits (30 on the horses, and 7 on the men), by the second, 34 hits were made (26 on the horses, 8 on the men). These numbers do not include 11 from the first fire, and 4 from the second, that could not be represented in the sketch, nor many others that struck the gun and limber.

Some have naturally a great facility in judging correctly the distance of familiar objects, while in others, the eye is long in habituating itself to the varied aspect they present, as they may be more or less remote. To guide the mind in the first instance, a variety of instruments have been devised, some simple and readily portable, others more ponderous and unmanageable.

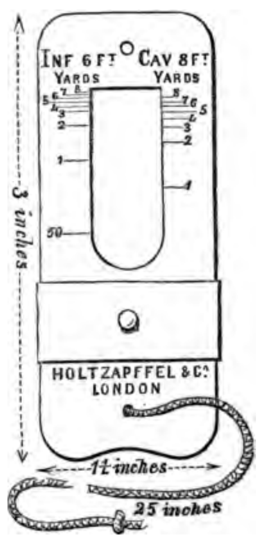
The simplest, but at the same time the least accurate, is a piece of sheet brass with a triangular opening cut in it; this is graduated, on one side for infantry, on the other for cavalry. To use it, the left eye is closed, the instrument (with the sides accurately perpendicular) is held parallel to the face, at the distance of 22½ inches, the figure to be measured, whether a man on foot, or on horseback, is brought within the graduated scale, which is moved

slowly sideways, till its upper and lower extremities just touch the upper and lower sides of the scale. Thereupon the figure on the scale will show approxi-



mately the number of yards intervening between the eye and the mark.

A much more accurate and ingenious contrivance is the stadium, made by Messrs. Holtzapffel (64, Charing Cross); it is provided with a sliding bar, which is pushed up with the right thumb, and is made to enclose the figure whose distance it is required to measure.



The woodcut in the margin represents on a slightly reduced scale, the form of the stadium and the length of the cord attached (25 inches).

With a little practice, the stadium can be used with facility, and as it is graduated with extreme accuracy, very satisfactory results are attainable for ranges extending from 50 to 800 yards.

held perpendicularly at arm's length, the butt touching the toe of the right foot, and each man having experimented and sufficiently tested the accuracy of his observations, is to mark with a fine file, a slight notch, to assist him on future occasions. But when we consider that to represent distances from 100 to 800 yards, the part of the bayonet to be thus graduated, would be less than half an inch in length, and that to mark the several ranges 400, 500, 600, 700, and 800 yards, 5 file marks would have to be made in the space of an eighth of an inch, we cannot hope to attain much accuracy by this means, nor indeed by any adventitious aid of the kind. In the American service, a stadium somewhat resembling Messrs. Holtzapffel's is worn by a chain fastened to the soldier's left breast, and such an appendage would at any rate be far more useful and appropriate than the whistle at present attached to the cross-belts of some riflemen. But the pupil must not hope by any such means to obviate the necessity for a long course of "Judging distance drill." Without it, his efficiency in the field will always be inconsiderable, let his skill as a shot be never so great.

The theory of judging distances, says Colonel Wilford is this:—"We take our men out to accustom them to make observations upon the size and appearance of objects and figures at different known distances, in order that they may have a record of facts in their own brains, whereby they may determine the distance of other objects. It is the brain that is concerned. We place men at known distances as points, the first at 50 yards, the next at 100 yards, another at 150, and so on up to 600 yards, (as shown in the accompanying engraving, which represents the actual appearance to an ordinary eye of men at those several distances). The soldier is told to observe the man at 50 yards, and to register in his mind all particulars

held

PLATE 7.

concerning his appearance. His attention is called to the fact, that at 50 yards off, he could name any man in his own regiment, as there is at this distance complete identification; for the age, complexion, height, and figure of a man can be determined. We next place the pupil in front of the man at 100 yards, and call him to notice those parts which he can *still* perceive at this distance, and those which he can *no longer* perceive. Thus we proceed up to 600 yards, when it will be observed, that at certain distances men appear to have no eyes nor necks, the head looks like a ball upon the shoulders, which are then never square but sloped off; the colour of flesh is not visible," &c.

After this lesson has been a few times repeated, the same objects are placed at unknown distances, for the purpose of testing the amount of attention and diligence that the pupil has bestowed upon the instructions he has received.

Registers are kept, in which the men are duly classed, those who are unable to judge distances, within certain limits as to accuracy, up to 300 yards, remain in the third class, those whose judgment is inaccurate up to 600 yards, remain in the second class, while those who are competent to form correct estimates at all ranges from 1 up to 1000 yards are advanced to the first class, and prizes for shooting are only awarded to those who are in the first class in judging distances, and are generally intelligent in other respects.

On one occasion, not long since, out of 107 officers who proceeded together to Hythe, 84 per cent. got into the first class. Out of 595 rank and file selected indiscriminately, after one short course of teaching, 473 were promoted to the first class, 107 to the second, while only 15 remained in the third.

In the preliminary judging distance drill just described, the men selected as "points for observa-

tion," are directed to "stand at ease," facing the "drill squad," looking to the front and maintaining an erect attitude.

These "fixed points" are thus thrown out. The instructor first selects a tree, house, or any other conspicuous object in the distance, and aligns two men thereon, twenty yards apart and facing each other. Then, ten paces to the right or left (as he may think proper) of the nearest man, and in the same line, he places another man as a point for covering. He next proceeds to march a squad of six men, formed two deep, on the alignment chosen, halting it at 50 yards distance, whereupon No. 3 of the rear rank, faces about, and covers the two men already aligned; the man 20 yards off is now removed. The squad then makes a half face to the right or left, and marches in an oblique direction for a distance of $50\frac{5}{8}$ yards or 61 paces; when it is again halted and No. 3 of the front rank is faced about three quarters either to the right or left, covering diagonally, moving to the right or left by the side step, as he may be directed, preserving his shoulders square to his present front. The squad continues to march in this manner in an oblique direction, leaving a man at every distance of 61 paces or $50\frac{5}{8}$ yards, who acts as already described, until every man is placed. When the "points of observation" are aligned diagonally, the covering point is no longer required. Each man in the above formation, it will be observed, is placed at a greater distance from the line first marched upon, in proportion as he is more or less distant from the point where the squad commences its instruction, in order that each soldier may serve, in turn, as a distance point, upon which the men of the squad may make observations.

An officer or non-commissioned officer, as assistant *or squad-instructor*, is usually placed opposite the

several "points of observation," and the squad is formed to the left of the squad-instructor placed opposite the point at 50 yards distance.

The instructor directs the men to notice particularly the position of the sun, the state of the atmosphere, and the background, at the time they are making their observations, in order that they may be accustomed to the changes made in the appearance of the several objects under the altered condition, arising from changes in the light and weather.

The instructor, opposite the 50 yards point, then indicates to each man successively the different parts of the figure, arms, accoutrements, and dress, which can still be distinctly perceived on the soldier before him, as also those parts that can no longer be perceived clearly at 50 yards; afterwards taking care to question him on the observations made on what he can see, and enjoining him to try and impress upon his mind the appearance of a man at this distance. The pupil then proceeds to the next station.

The instructor, opposite the 100 yards point, proceeds in the same manner; causing each man to make observations of the same kind that he did on the man at 50 yards, and desiring him to make comparisons between the two men placed at this and the former distances, and then passing him on to the next squad instructor, and so on until every man has made his observations on all the points.

The instructor opposite the 300 yards point, points out especially to each man, according to the observations he may make, the differences in the appearance of the men placed at the six distances comprised in the subdivisions of 300 yards, calling their attention also to those parts of the figure, dress, and equipments that are distinctly perceptible, those that are seen less clearly, and those that are no longer visible at all, at each distance.

The answers and observations from each man are rarely similar, because the powers of vision differ so much in different men.

The men placed as "points," are from time to time relieved by others who have made their observations at the several distances; for this purpose the squad should consist of at least double the number of men employed as "points." If the party be very large, points may be thrown out right and left; and in order to afford a view of the men at the several distances in two aspects, points may be thrown out in the opposite directions. When the whole of the men of the squad have made their observations on the different points, they proceed to estimate the distances of men within the limits of 300 yards in the following manner:—The instructor, after having marched the squad on to a different ground from that on which the apprecia- tion of distances has before taken place, places a man at any unknown distance, unobserved if possible, by the squad, formed opposite to this man, who is ordered to stand at ease. He then directs the men to observe the soldier facing them, and to estimate the distance, cautioning them at the same time to be careful to recollect the appearance of the men just seen at known distances.

The instructors, having formed three paces to the front of the right of their squads, then call each man separately to the front and question him, noting down his answer in a register, each reply being given in a low tone, in order that those who follow in succession may not be influenced by his opinion. No talking is allowed while the answers are being given. Every man is directed to adjust the sight of his rifle for the distance he judged.

When the men have all given their answers, which are to be read over to them by the instructor, in order to ascertain if they are correctly recorded, the men

are desired to pace the distance, by marching towards the man who has been acting as a "fixed point." The instructor marches in front of the centre, counting the number of paces aloud, the men counting them to themselves.

The men are taught to record, in the following manner, the distances they thus traverse:—At every 120 paces they double up one finger of the right hand, to mark 100 yards; commencing again 1, 2, 3, and so on. When at the end of any division of 100 yards, the remaining distance appears to be within 100 yards, they commence counting by *tens of yards*, doubling up a finger at every 12 paces. The correct distance, which is to be announced, is in every instance, however, ascertained by actual measurement with a cord, chain, or pace-stick, by men who follow immediately in the rear of the squad.

The pupils after having been drilled for four days to 300 yards, in the manner detailed, are exercised for four days more, up to 600 yards, first at known distances, in every respect as laid down for exercising to 300 yards, the "points for observation being two or more men, placed at every 50 yards from 350 to 600 yards inclusive, after first measuring 300 yards on the alignment chosen.

When estimating unknown distances beyond 300 yards, the party, in order to save time, is usually separated into two equal portions. These are moved in different directions, and when halted, face each other, with a file thrown out on the flanks a few paces off. After every man has judged the distance which separates the parties, and the answers have been recorded, they advance towards each other, counting the paces as before; each party measuring half the distance, and the two added together will give the correct distance.

The instructor in superintending all these exercises, takes care that they are conducted, as much as possible, in different directions, and under various states of the atmosphere, in order that the pupil may become habituated to the diversity of circumstances in which he may have to act. Every judging distance drill, it will be seen, consists of making observations on men placed at known distances, and of giving three answers on men placed at unknown distances in different situations immediately afterwards.

When tolerable proficiency has been attained, and the eye of the pupil is enabled to form a fair estimate of distances, the following course of practice is commenced and repeated periodically. Recruits and drilled soldiers are alike subjected to this discipline.

A cord or chain, of the length required for the practice, and divided into parts of five yards each, with the distance of each division from the end, so marked as to be discernible only on close inspection, is stretched in any convenient direction, care being taken to vary the ground for the several practices.

Two or three men, when judging to 300 yards only, but beyond that distance a section of not less than eight file, are stationed at the end of the chain that may be directed, to serve as objects to estimate from. The answers of each man are recorded in a register, kept by a serjeant under the superintendence of an officer. Strict silence is observed throughout the practice; the men are not permitted to consult together; and their answers are given in a low tone so as not to influence each other in any respect.

The instructor selects a division of five yards at which to halt the class, and cautions the men to complete a division of five yards in giving their answers. When judging distance with two or more classes, and *when* the ground is sufficiently level to lay down a

cord or chain, in order to save time and to render the practice more effective, the following arrangement is adopted :—

The instructor sends forward a party of one of the classes with a non-commissioned officer, as "points" from which the said class, as well as the others, are to judge their distance; the men so sent forward, at the same time estimate their own distance from the class to which they belong. The non-commissioned officer in charge of the "points" and the commander of each class are furnished, on the practice-ground, with a memorandum specifying the distance at which the points are to be stationed from the end of the chain for each judgment, so that they may each determine the correct distance, which is ascertained by deducting the distance at which the "points" are stationed from that at which the class is standing from the end of the chain. Care must be taken that the several classes are so situated as not to prevent those in their rear from seeing the "points."

When the ground is so irregular as to prevent the use of a chain, the correct distance, in the absence of an instrument, is ascertained by triangulation. The instructor having marched his party or class to the place whence he intends to judge, halts it about ten paces to the right of the chain and facing the points, and he arranges the non-commissioned officers who are to keep the registers, three paces in front of the right of the several sections, to prevent the answers, when given, being heard by those in rear. These non-commissioned officers first record their own answers, and then call each man of their respective sections to the front, to give his answer in yards as to the distance that separates him from the "point;" the answer is forthwith entered upon the register.

When each man's answer has been taken down,

they are read over to the men, so that any error may at once be corrected. The commander next proceeds to state aloud to the men the correct distance, and this is noted at once at the top of the column, and the number of points which each man has gained is registered at the side of his answer, and made known to him. In each practice, the men are exercised at six different stations. When the class has exercised at one station, it is moved to another, so as to prevent any clue to the actual distance being gained.

Upon the termination of every practice, the number of points obtained by each man is read over to the class, and inserted in the column "total points," these are added together, the sum being divided by the number of men exercising; the merit of the practice is thus determined. The register is then signed by the non-commissioned officer who kept it, and countersigned by the officer who superintended the exercise, to verify its correctness. The register being thus completed, on the practice-ground, the instructor affixes his initials to the "duplicate total points," and tears this column from the register, keeping it to check the entries made in the "Musketry drill and practice return" from the registers, the "total points" of which are transcribed into the return mentioned, by the company-instructor immediately after each practice. The register, in the case of recruits, is signed by the squad-instructor, and countersigned by the officer-instructor, the column "duplicate points" in that case not being torn off. No erasure is allowed in the registers of judging distance practice; and all necessary corrections are initialed by the officer superintending the practice. The "judging distance," like the "target" practice, is divided into three periods, each consisting of two *practices or* twelve answers.

The 3rd class practise as far as 300 yards, the 2nd to 600 yards, and the 1st as far as 900 yards. The value in points, of each man's answer, in the several classes, is as follows :—

3rd class: Or when judging distances between 100 and 300 yards -	Within 5 yards	- 3 points.	
	„ 10 „	2 „	
	„ 15 „	1 „	
2nd class: Or when judging distances between 300 and 600 yards -	Within 20 yards	- 2 points.	
	„ 30 „	1 „	
1st class: Or when judging distances between 600 and 900 yards -	Within 30 yards	- 2 points.	
	„ 40 „	1 „	

When either the first or second classes are brought to judge within the distance of an inferior class, (which, in order to test the proficiency of the men, is occasionally done,) the answers are valued according to the scale specified for the inferior class.

In the first period, each pupil is exercised in judging distances between 100 and 300 yards.

At the close of the period, the points obtained, are added together, and the sum entered in the column "total points" of the "Musketry drill and practice return," from which a classification is made, when all who have obtained fourteen points and upwards, pass into the second class, and those who have not obtained this number, are formed into a third class.

In the second period, the company practise in two classes, viz., second and third.

At the close of the period, the points obtained, being added together, and the sum entered opposite each man's name in the column "total points" of the prescribed return, a second classification is made, when all those of the second class who, having exer-

[illegible] obtained fourteen points and up- [illegible] the first class; and all those men of [illegible] have obtained fourteen points and [illegible] the second class. Those who have [illegible] number of points above specified, [illegible] second and third classes respectively. [illegible] period, the company are exercised in [illegible] viz., first, second, and third.

[illegible] of this period, the points obtained [illegible] and the sum entered, opposite each [illegible] in the columns "total points" of the [illegible], whence a final classification is made. [illegible] who, in the practice of the first class, [illegible] greatest number of points, will be deemed [illegible] judge of distance" of the battalion.

[illegible] two or more men obtain the same number [illegible] in the first class, then the best judge of [illegible] is the man who obtained the greatest number [illegible] in the three periods of practice.

In addition to these three periods of judging [illegible] practice, which are executed concurrently with the corresponding periods of target practice, the [illegible] are marched into the country by companies, under their respective captains, at least once a month, after the annual course of musketry instruction has terminated, to be exercised in judging distances.

In the Appendix, I have given an analysis of the Official Report of the last year's proceedings at Hythe, from which some valuable facts may be gleaned.

The following table specifies the number of drills, and practices which every non-commissioned officer and soldier of a battalion must go through annually. Every young officer before he is dismissed from drill, and every recruit before he is allowed to join in the practices of his company, has to go through the course here specified.

Preliminary Drills.	Young Officers and Recruits. Number of Lessons, Drills, and Practices.	Young Officers and Recruits. Number of Rounds.	Drilled Soldiers' Annual Course. Number of Lessons, Drills, and Practices.	Drilled Soldiers' Annual Course. Number of Rounds.	Remarks.
Cleaning arms	8	—	4	—	
Theoretical principles . .	8	—	4	—	
Aiming drills	6	—	4	—	
Position drills	16	—	8	—	
Snapping caps	2	20 caps	—	—	
Blank firing	2	20 rounds	—	—	
Judging distance drill . .	8	—	4	—	
Manufacture of cartridges	2	—	—	—	
Practices.					
Preliminary ball-firing .	4	20	—	—	Corps armed with rifles sighted only to 600 yards, omit the 3rd period of target practice: and the Royal Artillery are not required to execute the volley and skirmishing practices.
1st period	4	20	4	20	
2nd period . . .	4	20	4	20	
3rd period	—	—	4	20	
File firing	1	10	1	10	
Volley firing	1	10	1	10	
Skirmishing	1	10	1	10	
Judging Distance Practice 1st period . .	2	—	2	—	
Judging Distance Practice 2nd period . .	2	—	2	—	
Judging Distance Practice 3rd period . .	2	—	2	—	
Total . .	. .	90	. .	90	

This table only specifies the minimum number of drills through which the recruit is exercised, before he is allowed to fire ball ammunition.

The above is a condensed summary of the judging distance drill as at present taught at Hythe. If we

turn to the French Government manual, entitled *Instruction sur le Tir*, published as far back as 1853, we shall find that our authorities have had occasion to do very little more than translate that manual and adopt with some slight modification, the principles therein inculcated, not only as regards this particular subject, but in almost all that relates to modern musketry.

The Prussians, the Austrians, the Russians, in a similar manner, have copied the French model, while America, not to be behindhand, has followed the example set by our neighbours.

In proof of this I here subjoin a condensed extract from the musketry manual compiled by Captain Henry Heth, and published by the authority of the Adjutant-General at Washington.

"DRILL FOR ESTIMATING DISTANCES.

"The company assembled fully equipped as for drill, will be divided into at least three squads. Each officer is provided with a small cord, 25 yards long. The instructor will measure on the ground a right line, which will be marked off into distances—

0, 50, 100, 150, 200 yards;

0 50 100 150 200

marking these distances, as measured, with a stake, &c., on the ground. He will now direct each man of his squad, to pace off the measured distance of 100 yards, cautioning them to be careful and preserve their natural gait, without attempting to increase or diminish the length of their step. He directs the men to count the number of steps they take in passing over the distance of 100 yards. This, having been repeated three times by each soldier, who reports each time the number of steps taken by him in passing over 100 yards, the ratio which a yard bears to the

step of each individual becomes known. The instructor then informs each soldier of the number of steps it is necessary for him to take, to pass over 100 yards. The soldier now knowing the number of steps he must take, to pass over 10 and 100 yards, it will be easy for him to measure any distance with sufficient accuracy for all practical purposes when firing.

"To estimate a distance greater than 100 yards—in steps—the soldier, having started from the point of departure, will count the number of steps he should take to pass over 100 yards; extending as a tally, at the moment of arrival, the thumb of his right hand, the other fingers closed; he will recommence then his count, extending the first finger of the right hand when he has counted the number of steps necessary to make a second 100 yards, and so on, until he arrives at a point less than 100 yards from the point up to which he is to measure. When the soldier finds himself less than 100 yards from the object, he will count by tens, saying 'Ten yards,' when he has counted the number of steps necessary for him to pass over the distance of 10 yards, 20, 30 yards, and so on, until he arrives very near the object, when he will increase the length of his step, counting each step a yard; and by adding these to the tens, he will then only have to count as hundreds, the number of fingers he has raised, to know the whole distance, expressed in yards.

"The instructor will form his squad at one of the extremities of the 200 yard line, which has been measured in such a way that the right line measured shall be perpendicular to the front of the squad. He will order 4 men to place themselves, the first at the point marked 50 yards, the second at the point marked 100 yards, the third at the point marked 150 yards, and the fourth at the point marked 200 yards.

The men selected, should be as near the same height as practicable. The instructor will now direct the attention of the squad to the different parts of the dress, arms, equipment, and figure of the men on the line, such as can be easily distinguished and recognised at 50 yards, and such as cannot be readily recognised at that distance.

"He questions each man of his squad on these points, not expecting all to answer alike, since the eyesight of men will generally differ.

"The instructor will now call the attention of the squad to the soldier placed at the point 100 yards distant, and cause them to make similar observations upon this man as those already prescribed for the soldier at 50 yards. The instructor again questions the men, and will be careful to point out to them the difference that exists between those two distances, as illustrated by the difference in the appearance of the same objects at these distances. The instructor will make in succession, upon the two men placed at 150 and 200 yards, similar observations as prescribed for the men at 50 and 100 yards, being very careful to call the attention of each man to the difference which exists between the four distances, illustrated by the distinctness with which certain objects are seen. The instructor will direct the squad to notice that men appear smaller the farther they are off, although in reality they are nearly the same height. The men stationed at the different points will be frequently replaced by others. When the men of the squad have made a sufficient number of observations upon the four distances above indicated, and when these observations are well impressed on their memories, the instructor will cause the squad to estimate intermediate distances between 50 and 200 yards.

"In order to do this, the instructor will march his

squad to a different part of the ground from that on which he measured the distances in the first instance, and form it in one rank. He now sends out one man, directing him to halt at a given signal. The instant this man steps off the squad is faced about, in order that the men may not count the steps taken. When the man proceeds a sufficient distance he will be halted, facing towards the squad. The squad will now be faced to the front. The men will estimate the distance which separates them from the soldier. The instructor cautions the squad to recollect the observations made to them upon the men placed at the measured distances. The instructor, placing himself a short distance from the squad, calls each man to him in turn, directing them to give in their estimates in a low voice. This is necessary, in order that no man may be influenced in his judgment by the opinion of another. The instructor writes in his note book, opposite each man's name, the distance as estimated by him. The instructor will now cause the distance to be measured, and, at the same time, stepped off by the men. The instructor, having received from each man the distance as measured by him, will insert the same by the side of the distance as estimated. The instructor now points out to the men the errors, if any were committed, in estimating the distance. In order to do this more distinctly, he may send a man to the point from which the squad started, pointing out all errors by observations on this man. The instructor will repeat this exercise as often as, in his judgment, is necessary, taking care each time to choose a different distance, but always between the limits above indicated."

CHAPTER VI.

The arms of other days—The bow—Its use enforced—Skill of English archers—Their character in Spain in 1490—The introduction of firearms—Hand-guns—Early use of the rifle—The Brunswick rifle—Its want of range and precision—Flint muskets—Forsyth's introduction of the percussion principle—The English musket, pattern 1842—Erroneous opinions of military writers on the musket—Captain Norton's claims—Subsequent experiments—Enfield rifle, "pattern 1853"—Varieties of rifle projectiles—Observations upon them.

It will now be well to take a short retrospect of the arms of by-gone times, for the purpose of contrasting them with the more handy, powerful, and efficient weapon which the modern soldier wields.

Centuries ago, the archers of this country were renowned, far beyond those of the rest of Europe, and there is no reason why our riflemen should not, with the natural advantages they still possess, excel as marksmen, the sharpshooters of other countries. True it is, that not only in the adoption of the rifle, but in our system of musketry as well, we are but copyists. We have, nevertheless, shown in less important matters that we could adopt an invention and carry it to a degree of excellence far exceeding that which it had attained in the hands of those who originated it.

The bow—if we except only the sling—is unquestionably the simplest, and has been the most universally employed implement of offence ever known, and the earliest inhabitants of these isles, rude and barbarous as they were, possessed no ordinary skill in its use. But perhaps the full power of the bow, was not developed here, till some time after the battle of Hastings; from that period, and for the five centuries immediately succeeding the Conquest,

the archers of England were alike the admiration and the terror of their foes.

They were not, however, as some have imagined, a mere undisciplined host, practised only in shooting at a butt; they were regularly trained in the tactics of the day; while such was their mastery of the bow, that it was no extraordinary feat to transfix an iron breastplate at 80 or 100 yards.

When we see the bow now used as a mere toy, and notice, that with considerable practice, very little precision is observable among our toxopholites at any range beyond 60 or 80 yards, we find it difficult to credit the recorded achievements of bowmen in times long past, still more to assign the importance they were wont to claim for their art.

Roger Ascham, in the reign of the eighth Henry, in his "Toxophilus," terms archery—"In peace, an exercise most wholesome for the body, a pastime most honest for the mind, and of all others, most fitte and agreeable with learninge and learned men."

In the 6th and again in the 33rd year of the above monarch, it was enacted that all men-servants were to provide themselves with a bow and 4 arrows, to be paid for by their master, who was empowered to deduct the cost from their wages. Every man, too, under 60, not labouring under some impediment (judges and priests excepted), was enjoined to shoot habitually with the bow, while even lads, between 7 and 17, were to have their bows and 2 arrows. Any parent or master who suffered such youths, to be 2 months thus unprovided, was fined 1 noble (six shillings and eightpence).

None, under 24 years of age, were permitted to shoot at any standing mark, under a penalty of 4 pence for every shot, and no man above 24, was allowed to shoot at a less range than 220 yards, under a fine of a noble for each shot.

Even from the pulpit, exhortations to excel in this

national art were often heard. On the 12th April, 1549, Bishop Latimer, when preaching before the King (Edward VI.), took occasion to denounce the vices of the age, and to advocate warmly a revival of those noble and manly pastimes in which he had excelled in his youth. "In my time," said the prelate, "my poore father was as diligent to teach me to shoote, as to learne me any other thing; and so I think other men did their children; and he taught me how to draw, how to lay my body in my bow, and not to draw with strength of armes as other nations doe, but with weight of the body. I had my bowes bought me according to my age and strength, as it encreased in them, so my bowes were made bigger and bigger; for men shall never shoote well except they be brought up to it. It is a right goodlie arte, a wholesome kind of exercise, and much commended in phisicke."

Many acts of Parliament were passed, and many royal precepts were issued, to the sheriffs of counties, to encourage in every way the practice of archery. Butts were erected in every township for the people to shoot at on feast days, and if any neglected to do so, they were fined. The consequence of all which was, that the skill and power of those who kept up their practice constantly, is now regarded as almost incredible.

It is recorded, for instance, (by Gyraldus Cambrensis, the Welsh historian,) of a retainer of William de Breusa, a Norman knight, that the said retainer, who wore a buff coat under his armour, was by a Welsh archer, pinned through the hip to his saddle, his horse being killed by the same blow, then, as he wheeled round in his agony, a second arrow pierced the other hip.

Philip de Comines admitted that the archery of

England far excelled that of every other nation; and Sir John Fortesque affirmed, that "the might of the realme of England, standyth upon her archers."

It is not my intention here to comment on the sanguinary battle of Shrewsbury—one of the most desperate ever fought on English soil—which was, for the most part, a fight of archers; nor on that of Agincourt, which would never have been won, but for the prowess of bow-men. I will not do more than allude to the great battle of Towton in 1461, where 36,000 Englishmen and nearly the whole nobility of the country perished. On that fatal day the arrow, it is said, "drew most blood of any weapon that was plied:" and I will conclude this notice of our bowmen, with the following extract from the chronicle of the "Conquest of Granada" by Padre Antonio Agassida, because it is highly characteristic of the men-at-arms of that period, and yet, after the lapse of centuries, it might be taken as a truthful description of some of our countrymen even at the present day.

"This cavalier," says the chronicler, speaking of Lord Scales, "was from the island of England, and brought with him a train of his vassals, men who had been hardened in certain civil wars which had raged long in their country. They were a comely race of men, but far too fair and fresh for warriors; not having the sunburnt hue of our old Castilian soldiery. They were mighty feeders also and deep carousers, and could not accommodate themselves to the spare diet of our troops, but must fain eat and drink after the manner of their own country. They were often very noisy and unruly also in their wassail, and their quarter of the camp was prone to be a scene of loud revel and sudden brawl. They were, withal, of great pride; yet it was not like our inflammable Spanish pride; they stood not much upon the *pundonor* and high

punctilio, and rarely drew the stiletto in their disputes; but their pride was silent and contumelious.

"Though from an utterly remote and barbarous isle, they actually believed themselves the most perfect men upon earth, and magnified their chieftain, Lord Scales, far beyond the greatest of our grandees! With all this, it must be admitted, that they were nevertheless marvellous good men in the field, dexterous archers, and displaying tremendous power with the battle-axe. In their great pride and self-will, they invariably sought to press on the advance, and take posts of danger, trying to outvie our Spanish chivalry. They never rushed forward fiercely, nor did they make a brilliant onset like the Moorish and Spanish troops, but they went ever into the fight deliberately, and persisted obstinately, and were always exceedingly slow to find out that they had been worsted. Withal they were much esteemed, yet little liked by our soldiery, who regarded them as staunch companions in the field, yet coveted but small fellowship with them in the camp. Their commander was a most accomplished cavalier, of gracious and noble presence, and fair speech. It was a great marvel to behold so much courtesy in a knight brought up so far from our Castilian Court. He was much honoured by the king and queen, and always found great favour with the fair ladies about the court, who are indeed prone by nature to take delight in foreign cavaliers. He invariably went about in great state, attended by pages and esquires, and accompanied by noble young cavaliers of his country, who had enrolled themselves under his banner to learn the gentle exercise of arms.

"In all pageants and festivals, the eyes of the populace were attracted by the singularly gallant bearing and rich array of the English Earl and his train, who prided themselves on appearing always in the garb and

manner of their country; and they were, it must be admitted, something truly magnificent, delectable, and strange to behold."

But to return; with the invention of gunpowder, and the gradual introduction of firearms, both the long-bow and the cross-bow fell of course into disuse.

The hand-gun was pretty generally adopted in England about the middle of the 15th century. The arms which successively came into vogue after this, gave their names to the troops that were first provided with them. Thus the grenade, invented about 1594-1600, gave rise to the now honoured title of grenadiers. The dragon to that of dragoons. The fusil, a French invention (1630-40), to that of fusiliers. The musket, or musquetoon, which made its appearance about half-a-century later, to the musketeers.

Allusion has already (at page 9) been made to the origin of the rifle, which though it is now fast superseding all other small arms, has not been used in actual warfare for much more than two centuries.

In 1631 the Landgrave of Hesse armed three companies of chasseurs experimentally with this weapon. In 1645 the Elector Maximilian of Bavaria, equipped three light infantry regiments with rifles, intending to employ them principally in the minor operations of war. Frederic William of Prussia, when preparing for his campaign on the Rhine in 1674, distributed a few riflemen amongst each company of his infantry. Some years later, Frederic the Great, in order to enable him to encounter, upon more equal terms, the Austrian light troops, more particularly the Tyrolese sharpshooters, whose fire was exceedingly destructive, was compelled during the Seven Years' War, to add a company of men specially trained to the duties of skirmishers, to the effective strength of each battalion of infantry. In France, the cavalry were supplied with rifled carbines

before rifles were issued to the infantry. Towards 1674, Louis XIV. instituted some squadrons of cavalry, armed with what were even then termed "*carabines rayées.*" The name "carabine," said to be derived from the Arabic "*Karab*," signifying a weapon, was given in France, long since to all grooved arms; and the term *carabins*, served also to designate the troops who were first armed with these improved implements of destruction.

In the Musée d'Artillerie at Paris, there is a very curious and extensive series of old rifles. Three hundred and eleven of them are ·68 in. and under, in the bore, 32 are larger than ·68. Thirty-two have barrels not exceeding 19·50 inches in length. Two hundred and sixty-seven are between 19·50 and 39 inches long. Nineteen have straight grooves; 321 have inclined grooves; 131 have the grooves uniformly inclined. In 81, the twist diminishes from the breech to the muzzle; in 29 it increases in the same direction; while in no less than 83, the twist increases about the middle of the bore.

In 67, the grooves make (like the Enfield) one half-turn, or less, from breech to muzzle. In 219, the grooves make from one half to a whole turn. In fifty-five, from 1 to 2 entire turns. Two hundred and twenty-six have an even number of grooves, 117 an odd number. Seventy-nine have from 2 to 6 grooves, 232 have from 7 to 12 grooves.

Two hundred and seventy-five have grooves with rounded edges. Thirty-three have triangular grooves, 9 have rectangular grooves, and 26 have grooves not clearly defined.

Two hundred and ninety-six, have grooves ·11 in. and less in width. In 47 others, the grooves are wider than ·11 in. One hundred and fifty-three, have grooves ·0197 *in.* wide or less. One hundred and seventy-nine

from ·0197 in. to ·0394 in. wide, and in 14, the grooves are more than ·0394 in. wide.

This collection is interesting, as showing what a vast variety of experiments have been made, long since, on the subject of rifling. It is remarkable that amongst all these barrels, there is not one in which the grooves decrease in depth, nor is there one of the elliptic bore, described by Colonel Beaufoy in "Scloppetaria" as obsolete in his day, and of late years revived by Lancaster.

In 1680, the Life Guards of Charles II. carried rifled carbines in the proportion of eight to a troop.

In 1691, the subaltern officers of the Swedish dragoons were provided with the rifled carbine, and in 1700, those of the Prussian cavalry were supplied with similar weapons. In 1793, the first regulation model carbine for French infantry, was made at Versailles, the pattern for the cavalry being fixed about the same time. Rifles were soon however abandoned in the French army, on account of the difficulty experienced in loading them when foul.

In England, the rifle can hardly be said to have been fairly adopted, as a military weapon till 1794, when it appears to have been first used by a battalion of the 60th, or Royal American Regiment. The hint was not lost on other countries, especially in Austria, for in 1796, there were in the army of that country no less than 15 battalions of light infantry, most of whom were armed with rifles.

In 1800, rifles were placed in the hands of the 95th (British) Regiment, now known as the Rifle Brigade, and comprising five battalions. The rifles then supplied, weighed about 10½ lbs. each, with the sword, 9½ lbs. without; they were sighted for from 100 to 200 yards, and the barrel had 7 grooves, which made a quarter of a turn in the length of the barrel (2 ft.

6 in.). The entire length of the rifle was 3 ft. 10 in., diameter of bore ·623. The locks were remarkably well made, and were provided with detants, to prevent the nose of the sear from catching at half-cock; they had also bolts, to secure them from going off accidentally. The ball was spherical, and in loading was driven in with a mallet, which was dispensed with afterwards, when greased patches were substituted.

During the Peninsular war, our riflemen were supplied with balls of two sizes, the smaller being intended to be used, when quick loading was requisite. Baker, who made these rifles, says in his work, published in 1825: "I have found 200 yards the greatest range I could fire at, with any certainty. I have fired very well at times at 300, when the wind has been calm. At 400 yards and 500 yards I have frequently fired, and I have sometimes struck the object, though I have found it to vary much." Colonel Dixon, R.A., says: "In the early part of the present century, there was also introduced a rifled arm for cavalry. The barrel was 20 in. long, calibre 20, grooves 7, having the same pitch as those for the infantry. The 7th and 10th Light Cavalry were the only two regiments armed with them." But they soon discontinued the use of this weapon, because it was considered unfit for cavalry service. The Brunswick rifle was introduced in 1836. Its weight with bayonet, was 11 lbs. 5 oz., length of barrel 2 ft. 6 in., bore ·704. It had two deep spiral grooves completing one turn in the length of the barrel. It was sighted for 100, 200, and 300 yards. The bullet was spherical and belted, its diameter ·696, its weight 557 grains. The shooting of this arm was superior to our first rifle, though the loading was not so easy as was desirable, and a great disadvantage existed, in the necessity for keeping the bullet and cartridge separate in the soldier's pouch. The

grooves were deeper and rounder than those of the ordinary rifle; the projecting belt upon the ball, was made to fit the grooves. The ball was wrapped in a linen patch dipped in grease. It was found, that although the rifle loaded easily at first, yet that after long firing, the barrel became very foul, rendering loading nearly as difficult as under the old system of the indented ball. The belt on the ball, also caused considerable friction while passing through the air.

A committee of officers, assembled at Enfield to investigate the subject, reported—"That all firing with the Brunswick rifle, beyond 400 yards, was too wild to give a correct angle of its elevation." In 1844, it was tested at Antwerp, in experiments requiring an expenditure of 44,000 rounds, the result being, that it was declared to be the worst of all those tried on that occasion.

Muskets with flint locks, were used in France as long ago as 1630, but, with a characteristic tardiness, England did not adopt them until 47 years later. Such as they then were, they continued however, without any very marked improvement for more than 150 years.

At the beginning of the present century, the weight of the English musket and bayonet was 11 pounds 4 ounces, that of the bayonet 1 pound 2 ounces, length of the barrel 3 feet 3 inches, diameter of bore ·753 inch. The bullets used, were 16 to the pound. The charge of powder being 6 drachms (F.G.). Every soldier was furnished with 3 flints for every 60 rounds. Originally, it was the custom to prime the musket from a flask containing powder of a still finer quality, called "serpentine powder," but in the early flint lock musket, this proceeding was unnecessary, as in the act of loading, part of the charge passed through the touch-hole into the pan, whence it was prevented from escaping by the hammer.

In [illegible] times, the soldier was compelled to bite off [illegible] cartridge, and [illegible] prime before loading. [illegible] lock was, that it [illegible] the priming from wet. Sometimes [illegible] the priming, rendering it necessary [illegible] frequently. Owing to these [illegible] the Rev. Mr. Forsyth was [illegible] his attention to the subject, and [illegible] a patent for a mode of priming with a fulminating composition, consisting of [illegible] potash, sulphur, and charcoal. This powder [illegible] when struck smartly with any hard substance. [illegible] was, that it was too corrosive. [illegible] respect it was subsequently improved, and [illegible] to the musket, in the form of the present [illegible] cap, which contains chlorate of potash [illegible] parts, fulminating mercury [illegible] parts, ground glass 1 part. The experiments instituted for the purpose of testing [illegible] invention commenced in 1834. Six thousand rounds were fired from [illegible] specimens of each description of arm, and the experiments were [illegible] in all weathers. The result was extremely favourable to the percussion principle, and may be thus briefly summed up. In the first place, out of 6000 rounds from the flint lock, there were [illegible] miss fires, being 1 in [illegible]; whereas from the percussion musket there were only [illegible] misses in 6000 rounds, or 1 in [illegible]. With the flint lock, there were 3680 hits out of 6000, and with the percussion [illegible] hits, being 7 per cent. in favour of the latter. It occupied 32 minutes [illegible] seconds, to fire 100 rounds with the flint firelock, whereas the percussion occupied only 30 minutes [illegible] seconds. Another advantage of the percussion musket was diminution of recoil, as it admitted of a reduction of the charge, from 6 drachms to 4½ drachms. Hitherto a certain amount of powder

had been allowed for priming, but as this vestige of the hand-gun was dispensed with, a very considerable diminution could be made in the contents of the cartridge. Even the 4½ drachms then recommended, was known to be more than was requisite for the projection of the bullet, but an extra ½ drachm was retained, to allow for the effect of damp or waste. In the course of these experiments it was found that the very great force previously required to pull the trigger, might be advantageously reduced, and that increased accuracy would be the result; the pull of the trigger, therefore, was lessened to 7 pounds. The advantages of the percussion system having been satisfactorily demonstrated, it was decided that a portion of the old flint locks should be percussioned, and that a new model percussion musket for the English army should be determined upon. Hence, after a stagnation of about 200 years, a new pattern was at last issued in 1842. Its weight was greater than that of the old flint-lock, being, with the bayonet, about 11 pounds 6 ounces. The bayonet weighed 1 pound 3 drachms. The bore of the barrel was ·753 inch; barrel, 3 feet 3 inches in length, with bayonet 6 feet long; without 4 feet 6¾ inches. It was fitted with a block sight, suitable for 150 yards, and had a percussion lock. This arm and the Brunswick rifle continued to be the approved weapons for our infantry, with little or no improvement, until 1851, when the Minié was partially introduced. The English musket (pattern 1842, for the reasons already stated, page 15), was the worst of any then in use in Europe. It was actually less efficient even than the old Sikh matchlock! Yet the retention of this most contemptible arm, was pertinaciously upheld by many military men, for such reasons as those put forth in the following extract from the "Aide Memoire to the

Military Sciences." "Erroneous ideas prevail," says the writer, "as to the precise wants of the service with regard to the musket, and its proper qualities and utility in the field, as well as much exaggeration as to the defects of the new percussion musket of 1842 for the infantry of the line. It is stated that it is too heavy, and of imperfect construction. Some prefer the French pattern; and others would lessen the weight and calibre still more, reducing also the windage; as, however, the new regulation has brought into use some hundreds of thousands of new muskets, and has been approved by the highest authorities (!) some considerations are necessary before a radical change can be effected beyond range and a nice accuracy of fire—1st. What are the essentials for a musket, for the infantry of the line? 2nd. The application of the musket to the infantry soldier. For it is evident that the most essential points are, strength and facility of pouring into your enemies' ranks a powerful fire. Troops do not halt to play at long bowls. Firing at 500 or 600 yards is the business of artillery, and therefore to fire at 300 or 400 yards is a misapplication of the musket, a loss of time, a waste of ammunition, and tends to make men unsteady in the ranks."

The shooting powers of the musket 1842 are stated in the report on experimental musketry firing, carried on by Captain, now Lieut-Col. MacKerlie, Royal Engineers, at Chatham, in 1846, who writes as follows:—"It appears by these experiments, that as a general rule, musketry fire should never be opened beyond 150 yards, and certainly not exceeding 200 yards. At this distance half the number of shots missed a target 11 feet 6 in., and at 150 yards a very large proportion also missed. At 75 and 100 yards every shot struck the target only 2 feet wide, and

had the deviation increased simply as the distance, every shot ought to have struck the target 6 feet wide at 200 yards. Instead of this, however, some were observed to pass several yards to the right and left, some to fall 30 yards short, and others to pass as much beyond, and this deviation augmented in a still greater degree as the range was increased. It is only then under peculiar circumstances, such as when it may be desirable to bring a fire on field artillery when there are no other means of replying to it, that it ought ever to be thought of using the musket at such distances as 400 yards." In fact, it has been stated that the probability of hitting one man with a musket ball at 500 yards, would be, as one farthing to the National Debt. Our musket costs 3*l.*, the French and Belgian 1*l.* 8*s.* 6½*d.* In foreign arms, the barrel is fastened to the stock by bands, binding the two together, and thus adding greatly to their strength. It has been found, however, that with a thin barrel like the Enfield, these bands produce in time very injurious effects.

The French musket, although 3 inches longer, is beautifully poised, being very light forward. It was considered an advantage that the bore of our musket should be larger, because in war, their balls could be fired out of our barrels, while our bullets could not be used from their muskets. It was generally thought at one time, that the greater weight of the English ball produced an increased momentum and range, but this advantage was more than counterbalanced by the excess of windage.

From France, as has been already stated, have proceeded nearly all the modern improvements in fire-arms. The original French rifle (like our own) was loaded with a strong ramrod and mallet; it was found to give precision at the cost of diminished range;

For these reasons, during the early campaigns of the French revolution, the rifle was given up in the French army, but as their Chasseurs were found to be unequally matched against those of other armies, who surpassed them in accuracy as marksmen, a series of experiments were instituted, with a view to its re-introduction into their service. No satisfactory result was obtained until the occupation of Algeria, when Mons. Delvigne, of the Garde Royale, took the first important step towards its restoration. In the desultory wars kept up against them by Abd-el-Kader, the French found to their cost, that numbers of their men were struck by Arab balls at distances where the French musket was apparently powerless, and this they afterwards attributed to the length of the matchlocks of their enemies. These weapons were fired at a much greater elevation than was ever thought of by European troops. In order to put themselves on an equality with their enemies, Mons. Delvigne showed in 1828, how the rifle bullet could be made to enter the piece readily, and quit it in an expanded state; his method of loading, being as easy and simple with a rifle, as with a smooth-bore. Expansion was obtained by the introduction of a chamber at the breech, which was provided with an annular surface to receive the bullet, while upon it, a smart blow was struck with the rammer, and it was thus expanded into the grooves. The objection to the chambered rifle was, that after frequent firing, a residuum collected, which eventually left the powder less room in the chamber; it then necessarily reached above the annular shoulder, so that the ball resting upon the powder, instead of upon the shoulder of the chamber, was not so readily dilated by the strokes of the ramrod. To remedy this defect, the wooden *sabot* and greased patch, suggested in 1833 by

Colonel Ponchara, were introduced into the French service in 1839, and employed in Algeria in 1840, but several inconveniences resulted from the change. Colonel Thouvenin endeavoured to overcome these difficulties, by fixing at the bottom of the bore an iron shank, around which was placed the powder; this stem arresting the bullet, allowed it to be struck in such a manner as to cause the lead to penetrate into the grooves. These rifles are very apt to foul at the breech and around the pillar or *tige*, they are also difficult to clean, an instrument being required for the purpose. A spherical ball was used in the first instance, a solid cylindro-conical bullet was then resorted to; Mons. Delvigne and Minié having long previously experimented extensively with hollow cylindro-conical projectiles. Captain Norton, however, had long before—as far back, indeed, as 1823—shown the importance of giving an elongated form to all projectiles; the idea had first occurred to him upon an examination of the arrow, used by the natives of Southern India with their blow tubes. In propelling this arrow by the force of the breath, which they can do in calm weather to a distance of 70 yards, the fine elastic lotus pith, forming the base of it, expands and fills the bore of the tube, preventing loss of power by windage. This fact suggested to Captain Norton the principle of his "condensed arrow," which he submitted to the Select Committee on Fire-Arms, sitting at Woolwich in 1823. The projectile, intended for the musket, was four inches long: the base, corresponding with that of the Malay weapon, was formed of sheet-iron, and contained the charge, which expanded the base on ignition; and the head, forming the shell, was armed with a percussion cap. The Select Committee strangely enough reported "that the idea of this pro-

jectile was taken from the *poisoned* arrow of the Malays, and was therefore totally inapplicable to the service!" Colonel (afterwards General) Millar, however, a member of the Board, and considered one of the most scientific artillery officers of his day, observed, that although such a projectile would be inconvenient to carry, "if Captain Norton could contrive a shot or shell that would strike *point foremost*, it would be a contrivance of the greatest value." The hint was acted upon, and in the autumn of the same year Captain Norton proved its practicability. He then also ascertained the advantage of throwing the centre of gravity forward, effecting it by means which also produced the required expansion. In 1824, Captain Norton completed an elongated rifle shot and shell, the former being in all essentials identical with the present so-called *Minié ball.* He superintended numerous trials of these projectiles; in every instance they were attended with complete success. The Woolwich Committee, however, with consistent stolidity, reported that, "although the percussion shell might answer *Captain Norton's purpose* of blowing up ammunition waggons, yet that it could not be introduced with advantage into the service as part of the ammunition of rifle corps," actually concluding with the ridiculous observation, "that the projections on the shot, made to fit the grooves of the rifle, would be *liable to wear out by carriage in the soldier's pouch!*" In 1828, Captain Norton, undismayed by the frowns of the anile authorities at Woolwich, proposed for their adoption a rifle with *three* grooves, the regulation rifle having then *seven grooves.* The Committee reported as objectionable, that Captain Norton's rifle had "*only* three grooves," and with admirable consistency, not long after strongly recommended the introduction into the service of a *two-grooved* rifle, and

spherical belted ball! But being reluctantly forced to admit the utter worthlessness of the spherical ball, they at last condescended to adopt an *elongated or acorn-shaped shot*, on the precise principle of Norton's shot, with projections to fit the grooves of the rifle, and this arm, with modifications, more or less important, has at last become the basis of a system adopted throughout the whole of Europe. The acorn-shaped shot with projections, represented in Schauffern's celebrated "Treatise on Rifle Projectiles," as the bullet adopted almost universally on the Continent, is identical with that recommended by Captain Norton to the Woolwich Committee, previously to the introduction by them of the spherical belted ball.

Captain Norton continued for more than 30 years perseveringly to advocate the *elongated* form of shot for the rifle. He maintained that his shot and shell would carry, even the light end foremost, for 300 yards; and that this fact, so opposed to the general laws of projectiles, was caused by the powerful spin or rotary motion round its longer axis, imparted to the shot by the grooves of the rifle. A remarkable fact was elicited during his experiments, namely, that a solid leaden projectile, of the conical or acorn shape, when fired from a rifle, will expand for half its length from the base, but will not carry its point foremost during the whole of its flight, unless the centre of gravity be in the fore-part of the shot. It was also clearly established, that a *solid* shot of the same form and weight as Norton's elongated shot, many of which have been brought out with the assumption of originality by different amateurs, will not travel point foremost, during the whole of its flight; unless an accurate mechanical fit be secured in the first instance, the base being the heavier end, will, after the propelling influence has otherwise diminished, struggle to lead, thus inevitably deranging the accuracy of its

flight, whereas the hollow shot, having the centre of gravity in the fore-part of the shot, inevitably leads *point foremost.*

Notwithstanding the obvious advantage of the elongated shot on every occasion when they were tried, the Woolwich oracle, with amusing gravity, announced, that the "more it considered Captain Norton's remarks, the more it felt satisfied of their fallacy!" He suggests a condensed arrow with exploding head, and is accused of wishing to introduce *poisoned arrows* into the service: he proposes an elongated rifle carcass, and they tell him "that such a projectile was only fit for incendiary purposes." It would have been interesting to have heard from these sapient authorities, what designation they give to Shrapnell shells, and Congreve rockets. Such is a brief history of the elongated projectile, now admitted on all hands to be the one best adapted of any hitherto introduced, for small arms as well as for cannon. But who can peruse the few facts here put upon record, without feeling, that in the treatment Captain Norton has received, a most cruel injustice has been perpetrated, and that the Committee whose resolutions I have quoted, displayed not only the most lamentable want of judgment, but apparently total ignorance of the subject they were delegated to investigate?

Let us hope, that although, to the lasting shame of England, this gallant Peninsular veteran—whose life has been devoted to her service—has received neither honour nor acknowledgment of any kind; some substantial requital may yet be bestowed upon him for his most valuable and interesting researches. At any rate let us trust that the most important national interests will no longer be committed to men with scarcely the slightest pretension to scientific knowledge, and every one of whese decisions have been de-

monstrated to have been founded in error, and that the country will not for the future be deprived of the advantages resulting from the labours of really scientific men, by the recommendations of a few incapables who may have attained senility, without the experience it is usually supposed to confer, and without having apparently mastered the rudiments of their profession.* But of course all this is now changed, such blunders will not again be perpetrated.

Unquestionably, the admirable organization, the consummate tact, the strategic capacity, displayed throughout the Crimean war, and on still later occasions, are of themselves sufficient to dispel all apprehension for the future; taking therefore all these circumstances into account, together with the well-known ability of that host of military chieftains from whom selection would be made, and on whose wisdom the fate of the empire might hang, in the hour of England's need, it would be worse than folly to express even a passing doubt now as to our perfect security, under the direst contingencies.

In reflecting, as I have done, in the course of the preceding remarks, upon the want of discrimination of the Small Arms Committee of former days, I must distinctly disavow any allusion to those who are at present acting in the above capacity, nor must it be supposed that I desire to disparage their predecessors individually. I declaim only against the folly of a system which admits of the delegation of a most responsible duty to men, who very possibly with the best intentions have scarcely more than nominal qualifications for its discharge. To show its senselessness let me here recapitulate the circumstances above narrated.

* How much it is to be regretted that officers of the stamp of General Hay or Colonel Wilford, were not deputed in the first instance to examine and report upon Captain Norton's inventions.

In 1823, Captain Norton produces an elongated rifle shot, and is told that "such a projectile is wholly inapplicable to the service."	**In 1852,** The elongated projectile is demonstrated to be the only form of projectile applicable to the service.
In 1824, He perfects a bullet, precisely on the principle of the modern Minié, and is informed that "it could not with advantage be introduced into the service."	
In 1826, The Small Arms Committee pronounce it impossible to keep the point of an elongated bullet foremost at long ranges.	**In 1838, or later,** Captain Chads, of the "Excellent," found, that of 1500 of Norton's projectiles fired at 1200 yards, *the whole* kept their points foremost during the entire flight.
In 1826, Captain Norton brings out a rifle with three grooves, which is condemned because it had *only* three grooves.	**In 1853,** A three-grooved rifle is decided upon, as the only firelock suitable for the entire British army.
In 1835, Hearing that it was intended to introduce the two-grooved rifle into the service, and having experimented largely with it, and knowing its worthlessness, I wrote to that effect to a member of the Committee, pointing out the manifest defects of that system of rifling.	Soon after the introduction of the two-grooved rifle, all the defects I had previously pointed out were admitted, and the weapon was condemned and laid aside, after having cost the country incredible sums. So much for committees, red tape, and routine.

The chasseurs and Zouaves of the African army were armed with the *Tige*. Some years later, Captain Minié proposed the adoption of a bullet, which should receive its expansion from an iron cup placed in the hollow at the base, the cup being driven up by the gas, and thus forcing outwards, the sides of the bullet, into the grooves. In 1850, the fusil *rayé* with *balle à culôt* was issued to some French regiments of the line, and

the French Imperial Guard have since been armed with the old rifled musket, and provided with a hollow bullet without a cup. The French and Russians are said to be at present rifling all their smooth bored arms. Some assert that the idea of lengthened elliptical bullets was enunciated so far back as 1729, and that good results followed their employment, but it is doubtful whether experiments upon a satisfactory scale were undertaken with them at that time. Robins, in 1742, recommended the use of "egg-shaped" projectiles. They were to be fired with the heavy end foremost, in order to keep the centre of gravity forward, but they did not answer. In 1770, Monsieur Turpin tried elongated bullets at La Fère and at Metz. They were tried by Monsieur Guiton de Moreau in the years 2, 6, and 9 of the Revolution. They were proposed by Monsieur Bodeau in 1800, and in 1815 the Prussians also tried bullets of this description. Colonel Millar, Colonel Carron, Captain Blois, and others, also experimented with the conoidal bullet, and the great advantages attained with them, in comparison with those of a spherical form, induced them to propose the use of a conoidal bullet with the Brunswick rifle. This was done as an experiment, and succeeded tolerably; but at the same time the new arm called the Minié, pattern 1851, exhibited so much greater accuracy than the two-grooved arm, that nothing further was done with it in this country, though in Russia the Brunswick rifle with conoidal bullet is held in favour. The arm known as the "New Regulation Minié" was introduced into the service by the late Marquis of Anglesea, when Master-General of the Ordnance, and in this proceeding he had the cordial concurrence of the late Duke of Wellington. Its weight, with bayonet, was 10 lbs. 8¾ oz., bore ·702. It had 4 grooves making one turn in 6 ft. 6 in. The charge of powder was

$2\frac{1}{2}$ drs. The bullet weighed 680 grs. and was fitted with an iron cup. The diameter of the bullet was ·690, windage ·012. The Minié was first used in the British service in the Kaffir war, and subsequently at Alma and Inkerman, and it gave satisfactory proof that for once our authorities had taken a step in the right direction. Twenty-eight thousand were ordered, but in consequence of numerous quarrels among the contractors, this order was never completed. It was found that the precision of this form of Minié was improved by altering the shape of the bullet from conoidal to cylindro-conoidal, and the iron cup from a hemispherical to a conical shape with a hole in the apex. Lord Hardinge, on attaining the rank of Commander-in-Chief, zealously advocated the adoption throughout the whole of the British infantry, of a rifle musket of one uniform pattern, combining lightness with solidity, precision, and extensive range. Lord Hardinge invited competition from the principal gunmakers in the country. Of these, the following forwarded trial muskets for approval, viz., Purdey, Westley Richards, Lancaster, Wilkinson and Greener. The Minié (pattern 1851) and the 2-grooved (1836) were also subjected to a course of trial, before the committee assembled at Enfield in 1852, for the purpose of determining the best description of firearm for military purposes. Colonel Gordon says: "It should be noticed here, that with the exception of Mr. Wilkinson, every one of the makers changed either his musket or projectile during the trials, thereby causing them to be protracted much beyond the time originally intended." The diameter of the bore of *all* the new muskets was *less* than that hitherto in use, all the bullets were elongated, had auxiliaries for expansion, for the most part metallic, or, as in one case, were fitted with a horn plug. One pattern had "cannelures," and the whole

required the cartridge to be reversed in loading. It should be recorded, that the best shooting at these trials was from a rifle made at Enfield—almost as short as Jacob's—it was named the "Artillery Carbine," though not the one now used by the Royal Artillery. The barrel was only 2 ft. 6 in. long, the projectile was cylindro-conoidal, with an iron cup, weighing 620 grains: satisfactorily proving, that great length of barrel is not an essential in a rifle, though a certain length of barrel is required to fire in double ranks, and to give facility in the use of the weapon as a pike. With a small bore, there is great strength of barrel with little weight of metal, and great strength of stock with little weight of wood. A larger number of rounds of ammunition may be carried with the same effect. Greater precision, penetration, velocity, as well as a lower trajectory, are attained with small than with large projectiles of equal weight. The disadvantages of a small bore are, the slender form of cartridge, and the smaller hole made in the body of an adversary, as has been proved in the case of wild animals; in corroboration of this, it is also stated that they are found to run further, when wounded with a small ball, than they do when struck with a large one. At the same time this reasoning does not seem applicable to the human race, for it is presumed that most men would be equally disabled when wounded by a musket ball, whether the hole in their bodies were ·702 or ·530 of an inch in diameter; and in war, the object, after all, is rather to disable, than to kill, an enemy.

A puerile objection was made at one time to reversing the cartridge, viz., that drill with blank would be performed in a different manner to firing ball, and that in action the soldier would forget to reverse his cartridge, and put in the ball first. As the drill is now practised however, and as the present blank cartridges require to be treated precisely the same as ball ammunition,

this objection is removed. It has even been suggested that vermin would devour the lubricating mixture! For many years anterior to 1839, no sight at all was thought necessary for the musket, the bayonet stud being considered sufficient for all purposes, although it was totally obscured whenever firing was practised with fixed bayonets. When percussion arms were introduced (1842), one fixed or block sight was introduced as a grand improvement, but it was proposed to give the Enfield (1853) a sight that might be used up to 900 yards. Of course, loud was the outcry of Noodledom against so monstrous an innovation as that of giving to every common soldier a delicately made back sight, ranging to 900 yards, whether he knew how to use it or not; but this is now heard no more.

In August, [illegible], upon the termination of the trials at Enfield, two rifles were made at the Royal Manufactory, in which were embodied the improvements and alterations suggested by the experience obtained during the course of the trials. It was anticipated that they would possess the necessary requirements for a military weapon, and would prove superior to the Minie, the [illegible], and all those presented for trial by private manufacturers. The rifle thus originated, though weighing [illegible] lbs. less than the old musket, was nearly as strong, but more liable to injury from rough usage. Its weight, including bayonet, is [illegible] lbs. [illegible], the weight of barrel [illegible] lbs. [illegible] oz. The barrel is fastened to the stock by bands, an [illegible] with a thin barrel, for these bands, as I have already stated, in time seriously affect the [illegible]. The bayonet is fixed by means of a [illegible] ring, which, [illegible] The [illegible] is fastened with a screw. The [illegible] and was made upon a pattern suggested by Mr. [illegible]

Lord Hardinge, desirous to improve the projectile, and if possible to get rid of the iron cup, requested the leading gunmakers to lay any suggestions to this effect before the Small Arms Committee. One only was submitted, which was not a composite bullet, and that one was Wilkinson's. It was solid, with two deep grooves round it, but it did not maintain accuracy when made up into a cartridge, and the practice with it beyond 300 yards was very wild. Subsequently a bullet was proposed by Mr. Pritchett; it was like the former, cylindro-conoidal in form, with a small cavity at the base, rather with the view to throw the centre of gravity forward, than to produce expansion. The weight of this bullet was 529 grains, and it yielded excellent practice at Enfield up to 800 yards. Its adoption was accordingly decided upon, to the exclusion of the Minié with the iron cup.

In 1853, not long after the establishment of the School of Musketry, 20 Enfield rifles were sent to Hythe for competitive trial with the Minié, and also with Lancaster's elliptical rifle; on these trials the superiority of the Enfield was declared to be satisfactorily proved.

Carbines bored on the elliptic principle are however used by the Royal Engineers, and have been found, with recent improvements in their structure, to be superior to the Enfield. These arms have the same bore as the Enfield (pattern 1853), and can be used with the ordinary regulation ammunition; indeed greater precision is attained even with these rifles when the bullet, fitted with boxwood plug, is employed.

In May, 1855, the ammunition supplied to Hythe was discovered to be in a most unsatisfactory condition; bullets of various diameters being found in every package of cartridges. The result was, that bullets of the correct size (·568 in.), then in use,

afforded accurate practice at 600 yards, while those of less diameter were most irregular in their flight. To obviate this difficulty General Hay recommended a return to the iron cup bullet, when more uniform expansion resulted, and consequently greater accuracy was attained.

At Woolwich they had at this time seven dies continually at work making bullets; these dies were made small at first, as they gradually wore larger. When they became too large, they were at once replaced. The failure of our ammunition was imputed to inaccuracy in the dies. General Hay subsequently suggested a most valuable and important improvement. He effected expansion infallibly, by the use of a wooden plug. After a long series of careful experiments, this system was proved to be incontestably superior to any that had previously been devised; the use of the box-wood plug has accordingly become general throughout the British army.

Uniform accuracy can only be attained by such an arrangement as shall impart to each bullet in succession sufficient and equal expansion, producing thereby such a degree of rotation as shall continue during the whole trajectory. With sufficient lubrication, the more perfect the expansion, the less the barrel will be found to foul.

When proper care has been observed, the Enfield has frequently been fired 200 times successively, without any difficulty in loading. In the spring of 1858, the rifling of the regulation arm (pattern 1853) was changed, from grooves of an uniform depth of ·014 in., to channels ·005 deep at the muzzle, increasing in depth to ·015 in. at the breech. These rifles shoot well when new, but they require increased elevation at long ranges. How far shallow grooves of this *kind will* answer, or how long it will take, by the

ordinary wear and tear, to obliterate the rifling altogether, yet remains to be ascertained. I am of opinion, from close and attentive observation, that we shall have reason to regret the change. Rifle regiments and all serjeants of infantry are provided with a weapon which takes the same ammunition as the regulation arm, but is six inches shorter in the barrel. This is the "short Enfield." Those for rifle corps are mounted in steel with a short bayonet, while those for serjeants of the guards and for the line, have brass mountings, and the ordinary bayonet.

At Hythe and elsewhere, where careful trials have been made with both the long and the short Enfield, the advantage at great ranges has almost uniformly been in favour of the larger barrel, and I believe Colonel Wilford gives it a very decided preference. So far as my own experience has gone, I have certainly not found much difference between the precision of these two particular rifles, up to 550 or 600 yards. From 600 to 900 yards the superior accuracy of the long Enfield was very decidedly marked. On the other hand, the longer barrel is perhaps somewhat more liable to injury, and it is on the whole a less handy, compact, and convenient weapon than its rival.

To show what a marvellous amount of ingenuity has from time to time been brought to bear upon the subject of rifle projectiles, I have collected in the two following plates sixty of the principal varieties of bullets. All of these have in their turn had numerous advocates, and many of them are still in use in different services.

The number I could have given might of course have been greatly augmented, but those here represented include the most important modifications of rifle missiles that different inventors have from time to time designed, and these specimens will fully answer the particular purpose I here have in view.

EXPLANATION OF THE PLATES.

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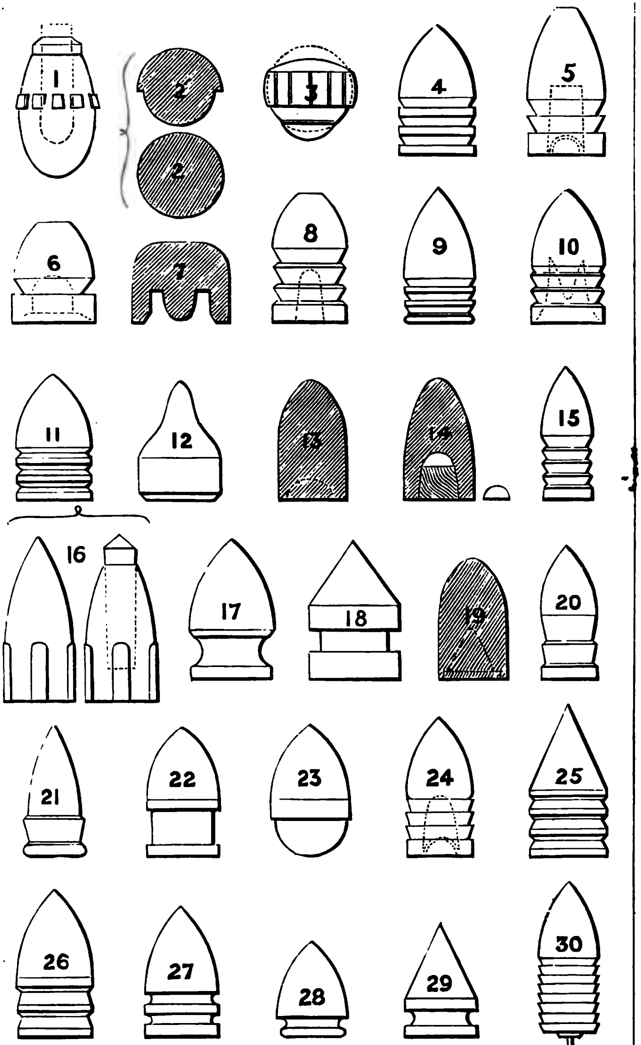
1. Captain Norton's original elongated percussion rifle shell, fitted with wooden plug; used by him more than thirty years ago.
2. Section of an ordinary spherical ball.
2'. ,, of the same, compressed, in the barrel, on Delvigne's system.
3. Section of the same, compressed on Ponchara's system.
4. Bullets used by the Chasseurs de Vincennes and Zouaves.
5. Original Minié bullet, with iron cup.
6. Bullet originally used by the French Imperial Guard.
7. ,, invented by Lieutenant Nessler (section).
8. Modification of the Minié.
9. Bullet used by Belgian riflemen.
10. ,, ,, ,, infantry.
11. ,, (last) adopted by the Sardinians.
12. ,, ,, ,, Bersaglieri.
13. Pritchett Enfield (section).
14. Regulation Enfield, with box-wood plug (section), (the cup formerly used, is shown at the side).
15. Bullet originally introduced for Prince's breechloader.
16. Jacob's bullet and shell.
17. Bullet for the Russian *tige* rifle.
18. Austrian bullet (now obsolete).
19. Boucher's disc bullet (section).
20. Swiss Federal bullet.
21. ,, Wurstemberger bullet.
22. Major Nuthall's bullet.
23. Bullet used with the Prussian needle gun.
24. Prussian modification of Minié, with iron cup.
25. Prussian bullet for Thouvenin's *tige* rifle.
26. ,, ,, Delvigne's rifle.

PLATE 8.



RIFLE PROJECTILES.

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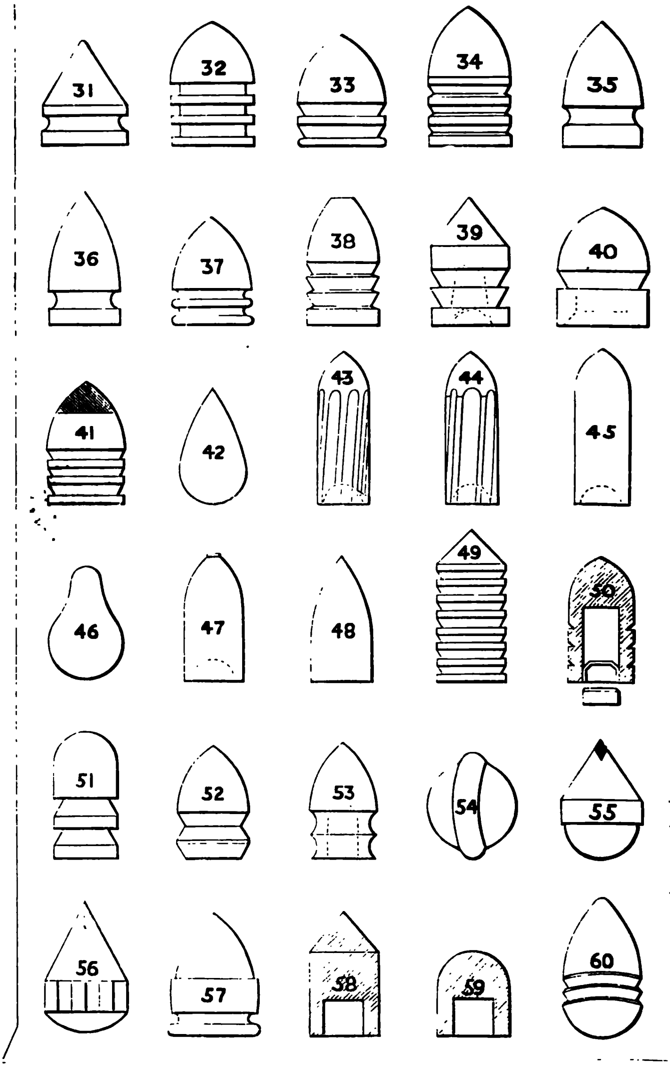


RIFLE PROJECTILES.

[To face page 145.

27. Saxon bullet (No. 1).
28. ,, ,, (No. 2).
29. ,, ,, for *tige* rifle.
30. Spanish bullet (M. Riera's) containing the charge of powder as well as the explosive composition.
31. Hanoverian bullet.
32. Bavarian ,,
33. Oldenburgh ,,
34. Nassau ,,
35. Bullet for Norwegian breechloader.
36. French modification of Minié, without cup.
37. Bullet for Mecklenburgh *tige* rifle.
38. Spanish modification of the Minié.
39. Neapolitan ,, ,, ,,
40. Bullet now used by the French Imperial Guard (modification of No. 6).
41. Steel-pointed bullet used by the Chasseurs de Vincennes.
42. American "picket."
43. Bullet for Westley Richards' octagonal breechloader.
44. Whitworth's hexagonal bullet.
45. ,, cylindrical ,,
46. Bullet formerly used by the Bersaglieri.
47. Lancaster bullet.
48. American (the last adopted).
49. Bullet invented by Captain Tamissier, of the French Artillery.
50. Baden modification of the Minié, with tinned iron cup.
51. Wilkinson's bullet.
52. Danish.
53. Delvigne's improved bullet.
54. Belted Brunswick ,,
55. Captain Tamissier's steel-pointed bullet.
56. The same, after having been compressed into the grooves of the rifle.
57. Bullet recently adopted in Saxony.
58. Delvigne's original bullet.
59. Captain Thierry's ,,
60. ,, Mangeot's ,,

Fig. 1 is an exact representation of a rifle shell cast by me, upwards of 20 years ago, upon the precise principle advocated by Captain Norton, a long time previously. The dotted line shows the position occupied by a plug of wood, fitting the hollow in the bullet, at the base of which cavity, a few grains of percussion powder were placed. The instant the shell (which invariably flew point foremost) struck the object aimed at, the plug—driven home on the fulminating composition—exploded it, and fired whatever it came in contact with. I have used hundreds of these shells and never knew one explode in the barrel, nor fail to ignite the charge into which it was sent, however great the range. The right-hand diagram, Fig. 16, shows the outline of General Jacob's shell, invented by him in India, some 25 years after Captain Norton's had been brought out in England, though I believe the General had no cognizance of that fact.

Of the several foreign rifles here represented, the most important is the "Swiss federal" (Fig. 20), a modification of the one known as the Wurstemberger (Fig. 21). According to official reports of its performance, which have been sent me, it excels in precision every other rifle; while its trajectory is the lowest. In these trials, the Bavarian (Fig. 32) is said to have ranked next to the federal. This appears extraordinary, for the form of the bullet is open to several obvious objections. With the "Swiss federal" rifle at a range of 655 yards, the dangerous distance is 98 yards; at 820 yards it is 73; and at 983 yards, the dangerous space is 57 yards; at 1308 yards, the dangerous space is 28 yards. The bullet possesses considerable power of penetration, while the weight of the ammunition carried, is materially reduced. The total weight of this Swiss rifle, with 60 rounds of

cartridge, is 13·4 lbs. That of the French carbine, with 60 rounds, 18·5 lbs. The recoil is slight, less indeed by one-fifth than that of the Enfield, and less by one-third, than that of the French *tige* carbine. The recoil of the carbine, used by the Swiss chasseurs, is rather greater than that of the "federal" rifle, the recoil of which has been ascertained to be 33·64 lbs. to 34·74 lbs. The recoil of the chasseur rifle is 35·29 lbs.; of the Enfield rifle, 39·70 lbs.; and of the French *tige* carbine, 44·11 lbs. to 46·32 lbs.

At Fig. 2, is shown an example of the particular system of expansion first introduced by Delvigne, whereby a spherical bullet was flattened by the ramrod, while resting upon the shoulders of the chamber. Ponchara's and Berner's (Fig. 3) differed from this, inasmuch as rotation was here communicated to the bullet by means of projecting wings, that fitted the rifle grooves.

Thouvenin expanded the ball by flattening it upon a *tige*, by blows with the ramrod (see Fig. 25). The subsequent modification of Delvigne's system of expansion, by the adoption of a deep cavity in the bullet, is seen at Fig. 58. A later improvement still, at Fig. 53.

Upon this principle were most of the French rifles made in 1840 and 1842, the old short rifle of the Austrian as well as of the Belgian riflemen, and the carbine of the Sardinian Bersaglieri. This system it was, that brought about—almost compulsorily—the change that has of late taken place in the arms of European infantry generally. The ball, under the arrangement above alluded to, entered the barrel readily, and rested at the breech upon the shoulders of the chamber; two or three light blows of the rod sufficed to force it into the grooves. The slight space left between the projectile and the powder favoured

its complete combustion. The advantages thus secured, were a facility of loading equal to that of the smooth-bored musket, and increased precision; but the concomitant evils, were rapid fouling, and a complication of the cartridge by the use of what was termed a *sabot*, which was constantly liable to break.

Fig. 23, represents the shape of the bullet used with the Prussian breech-loading needle-gun.

The supposed advantages of this arm are, rapidity of fire, facility of loading under all circumstances, and considerable accuracy at short ranges. But these are more than counterbalanced by difficulty in adjusting and preserving in order the different working parts, added to a liability of the needle to bend, to corrode at the point, and to break. But the crowning defect is a liability to miss fire—this involves a removal of the cartridge and the substitution of another. To all this must be added the great danger that will always attend the transport of cartridges that contain the fulminating composition: and lastly, an utter impossibility of using the arm at all, if its particular cartridge should fail.

CHAPTER VII.

Gunpowder and its explosive powers—Proportions of the ingredients of English powder—The composition of the powder of different nations—Process of manufacture—Theory of its explosion—Volume of gas generated—Its pressure—Weight—Heat evolved—The velocity of its expansion—Temperature generated by the explosion—Rapidity of its combustion—Heat necessary for its ignition—May be exploded by percussion—Explosion not instantaneous.

A WORK of this kind would necessarily be deemed incomplete, without a few observations on that black dust, which has revolutionized warfare, destroyed millions of human beings, and has, perhaps, exercised a greater influence on the history of the world than any other invention that could be named.

One remarkable circumstance connected with it is, that notwithstanding the advances men have made of late years in scientific knowledge generally, and more particularly in chemistry, the ingredients used in the manufacture of powder are absolutely, and the proportions in which they are combined, remain almost, the same as they were five centuries ago. A variety of substances have been tried, either in combination with, or as substitutes for, either the nitre, the sulphur, and the charcoal, now universally used in the manufacture of this explosive compound.

Attempts have, from time to time, been made to manufacture a composition of greater strength than gunpowder, the experimentalists losing sight of the fact that the objects they sought were attainable, simply by using larger charges of ordinary powder.

It is true that a good and serviceable powder may be made, by a combination of 80 parts of chlorate of potassa with 20 of charcoal only, but the grain is not very compact, and it rapidly corrodes the barrel of a gun. But for reasons, upon which it is not necessary now to dilate, no great advantage would in fact be gained by the use of a powder of much greater strength than that in ordinary use. Robins, more than a century ago, showed that whenever the initial velocity of a projectile exceeds 1140 ft. per second, a vacuum is formed behind it, which, by increasing the anterior resistance, reduces the velocity to what it would have been with weaker powder or a smaller charge.

The proportions adopted by most English makers are nearly identical—viz., for every 100 lbs. of powder,

Saltpetre	77½
Sulphur	10½
Charcoal	16
	104 lbs.

(The odd 4 lbs. being allowed for waste.)

The atomic composition is 1 equivalent of nitre, 1 of sulphur, and 3 of carbon, or

Saltpetre	74·6
Sulphur	11·9
Charcoal	13·5
	100·

And that these proportions are pretty closely adhered to by the manufacturers in other countries, the following table conclusively shows.

A table showing the composition of the gunpowder used by different nations.

	Cannon Powder.			Rifle Powder.		
	Nitre.	Sulph.	Charcoal.	Nitre.	Sulph.	Charcoal.
Austria—(musket)	72·	16·	17·	75·5	11·3	13·2
Do. (sporting)	70·	16·	17·	75·5	11·3	13·2
Bavaria	75·	12·5	12·5	75·5	11·3	13·2
Chinese	75·7	9·9	14·4	...	...	...
England (sporting)	76·	9·5	14·5	88·	9·25	12·75
Do. Royal Mills, Waltham Abbey	75·	10·	15·	76·5	9·	14·5
France—Imperial Establishment	75·	12·5	12·5	75·5	11·30	13·2
French—for sporting purposes	76·9	9·6	13·5	...	...	...
Do. for mining purposes	62·	20·	18·	...	...	...
Hanover	71·2	10·8	18·	75·5	11·3	13·2
Hesse, Electorate	73·4	13·3	13·3	75·5	11·3	13·2
Hesse, Grand Duchy	74·4	10·6	15·	73·7	10·7	15·6
Holland	70·	14·	16·	...	...	...
Portugal	75·7	10·7	13·6	...	...	...
Prussia	75·	11·5	13·5	73·7	10·7	15·6
Russia	73·78	12·63	13·59	80·	8·7	11·3
Saxony	75·5	8·2	16·	76·5	10·5	13·
Spain	76·47	12·75	10·78	75·5	11·3	13·2
Sweden	76·	9·	15·	76·5	10·5	13·
Switzerland	76·	10·	14·	76·5	10·5	13·
United States (America)	75·	12·5	12·5	...	...	...
Wurtemberg	75·	12·	13·	74·5	10·7	14·8

The due admixture and incorporation of the ingredients, is a work requiring not only much labour but considerable skill. When properly blended together the mass is called "mill cake," and is subjected to a pressure of 75 tons to every superficial foot. It then becomes "press cake," after which it is crushed between toothed rollers of successive gauges, or broken into small pieces and passed through sieves, with meshes of different dimensions. The next process is called "glazing." The powder, for this purpose, is placed in canvas cylinders or casks, made to revolve at the rate of 40 revolutions per minute. The pressing and glazing impart no strength whatever to the powder, but merely give equal density to the grain.

and polish to the surface, rendering it less liable to absorb moisture, and better able to stand friction and carriage.

It is now dried thoroughly at a temperature of about 144°, and is then ready for use.

The theory of the explosion of gunpowder is this: The sulphur accelerates deflagration and supplies heat; the nitre furnishes both oxygen and nitrogen; and the carbon, by its strong affinity for oxygen, promotes the decomposition of the nitre, combining with its oxygen, so as to produce carbonic acid gas.

Professor Graham gives the following view of the results of the combustion of gunpowder as consistent with actual experiment:—

Before Combustion.		After Combustion.
3 Carbon	3 Carbon	3 Carbonic Acid.
	6 Oxygen	
	Nitrogen .	1 Nitrogen.
	Potassium	Sulphate of Potassium.
Sulphur	Sulphur	

On coming into contact with the atmosphere, the sulphuret of potassium is converted into sulphate of potash, thus causing the white smoke which follows the explosion of gunpowder.

According to some experimentalists, the volume of gas generated by the explosion, when cold, is 250 times the bulk of the powder burnt; but the enormous heat evolved by the combustion, causes it to occupy at least 3 times the space that it does, when subsequently cooled.

Piobert states, as the result of numerous carefully conducted experiments, that the first pressure of the fluid generated by the explosion of powder when 1 bullet is placed in a barrel, is equal to 2500 atmospheres; when 2 bullets are used, to 2700 atmospheres;

when 3, to 2880; and when 13 are used, to as much as 3040. The conclusion being, that the *total* pressure of the fluid, during the passage of the bullets along the barrel, is greater when their weight is increased.

It has been ascertained that the weight of the gas generated, is equivalent to three-tenths of the weight of the powder burnt; and, as already stated, when cold, its bulk, under ordinary atmospheric pressure, is 250 times that of the powder.

We may reasonably infer, that if the fluid in question, occupied a space equal to the volume of the gunpowder, its elastic force, when cold, would be 250 times greater than the pressure of the atmosphere under ordinary circumstances.

Robins was of opinion that the heat evolved was certainly not less than that of red-hot iron. By actual experiment he ascertained, that air heated to this temperature had its elasticity quadrupled, and therefore that the force of gas from powder is probably ($4 \times 250 =$) 1000 times as great as the elasticity of the air, measured by its pressure on an equal superficial extent.

The ordinary atmospheric pressure is nearly 15 lbs. upon the square inch; the pressure of the elastic gas, to which allusion has been made, would therefore, upon the same area, at the instant of explosion, be equivalent to 15,000 lbs. on the square inch.

The strength of gunpowder is the same, whatever is the density of the atmosphere, but moisture, held in suspension in the air affects it considerably. Thus the same charge of powder, which would give a bullet an initial velocity of 1700 ft. per second on a comparatively dry day, would not, during damp weather, give more than 1250 or 1300 ft.

The velocity of the expansion of the gas is a pro-

perty upon which the chief propulsive power of this substance depends.

The flame of gunpowder is said to expand at the muzzle of a gun with a velocity of 7000 feet per second. It has been calculated, that one cubic inch of powder is converted into 250 cubic inches of gas, at the temperature of 60° Fah., and as at the moment of explosion its volume does not increase less than 8 times; one cubic inch of powder, if confined at the time of explosion, would exert a pressure of about 30,000 lbs. on the cubic inch, or more than 5000 lbs. on the square inch.

The temperature to which the gases are raised at the instant of the explosion, has been estimated by some experimentalists to be as high as 4000° Fah., or about the melting point of copper. All gases expand uniformly by heat, the expansion having been proved to be 1-480th for each degree of Fah. Reverting then to the calculation already cited, relative to the expansion of powder, and assuming that it expands 250 times at the mean temperature of the atmosphere, while the heat evolved, amounts to 4000° Fahr.,* each volume of gas would—as already stated—at the temperature of 4000°, be increased rather more than 8 times in volume.

But we are forced to admit, that in the present state of our knowledge on the subject, the precise extent of the force of gunpowder cannot be accurately determined, though a tolerably near approximation to the truth is attainable. Although much has already been ascertained, much more still remains to be accomplished, and the importance of the subject is such that it well deserves much further research.

The applicability of gunpowder to military purposes, depends mainly upon the rapidity of its combustion,

* Captain Boxer calculates that the heat generated by good dry powder is not under 3000° Fahrenheit.

though the rapidity must not be too great. It may be fired in a variety of ways, but whatever be the method used, one portion of the substance, must be first raised to a temperature, a little above that necessary to sublime the sulphur which may be eliminated, by gradually raising the compound to a heat sufficient to drive it off in the form of vapour.

The heat necessary for this purpose, is about 660° Fah. Gunpowder may be ignited by the percussion of copper against copper, copper against iron, lead against lead, and even with lead against wood when the shock is very great. It is more difficult to explode gunpowder by striking it between copper and bronze, or bronze and wood, than between the other substances.* Of 20 samples, wrapt in paper, and struck smartly upon an anvil with a heavy hammer, seven of grained, and nine of mealed powder exploded.

When a charge of powder is exploded in the chamber of a gun, although the whole force generated may seem to be instantaneous, this is in fact, not the case, a certain lapse of time being necessary to the complete combustion of the substance. This gradual firing of the component particles of the powder is of very great importance. Were it otherwise, the gun, unless of enormous strength, would inevitably be riven asunder, while the bullet would probably be either blown to pieces, or else not sent out of the barrel. In such a case, the prodigious force brought suddenly to bear upon the material at one point, would prevent an equable and uniform distribution of its action over that portion of the metal of which the barrel was composed, situated at any distance from the explosion, before those in its immediate vicinity were forcibly rent apart.

* Bronze consists of 78 parts copper to 20 of tin. Bell metal, 78 copper to 22 tin. Gun metal, 100 copper to 8 to 10 tin. Brass, 2 copper, 1 zinc, and calamine stone to colour and harden.

I have indeed proved this, by loading a strong rifle barrel with half a drachm of the ordinary percussion powder, placing a bullet over it; the result was, on firing the charge, that the barrel was split, the breech blown out, while the bullet was scarcely moved.

When the charge of powder in a gun is exploded, the grains being successively surrounded by the heated gas, each grain may be considered as ignited over its whole surface at once.

Were the grains all equal and of regular form, the time each would take to consume, might be easily calculated, but since in ordinary cases they are irregular in form, although the grains may be of similar weight, the time necessary for their complete deflagration will necessarily be very different.

The rapidity of the combustion depends upon the absence of moisture from the powder, the density of its composition, the proportion and quality of its ingredients, no less than upon the mode of its manufacture.

The velocity of the expansion of the gas given forth by the explosion of powder is very considerable, but the grains composing the charge obstruct the expansion of the gas; the velocity is consequently much diminished, but it is far greater than the velocity of combustion. M. Piobert estimates the velocity of the transmission of the flame of a charge, in a gun, at about 38 ft. per second, but this is probably a very low estimate. Many observations have been made on the velocity of the ignition of trains of powder, under various circumstances, but they afford no data for judging of its rapidity in a confined charge.

In these experiments, the increased surface exposed to the heated gas, more than compensated for the diminished facility afforded to its expansion, and a train of small-grained powder laid upon an open

surface will generally be consumed more quickly than a train of large-grained powder.

But in a piece of artillery this is not the case, a circumstance, which, amongst others, accounts for the diminished initial velocity given to the shot, by a charge of small-grained musket powder, as compared with one of large-grained powder.

With large-grained powder the action in a rifle or in a gun with a small charge, is greatest with powder of low density, while with very small grain, the highest velocities are usually obtained, with the powder of great density; but in heavy guns with the service charges, the large-grained powder should be of considerable though not of excessive density, to obtain the greatest effect.

The products of the combustion of powder have been already shown to be both gaseous and solid. The gaseous consisting chiefly of nitrogen and carbonic acid; the solid, of sulphur and potassium mixed with a little charcoal. The solid products are for the most part volatilized by the high temperature generated by the explosion. The fouling of a gun-barrel is occasioned by the decomposition of the solid residuum above described. Of these, the most obnoxious is the sulphuret of potassium, a salt which readily absorbs moisture from the atmosphere.

On a clear day, therefore, the fouling does not attain the semi-fluid state usually observable in damp weather. This deposit is unfortunately not easily removable. The amount of fouling depends much upon the quality of the powder used. With a foul barrel there is always loss of power, from the increased friction, and there is also inaccuracy both in direction and elevation, if the fouling be so considerable as to fill the grooves and prevent the projectile from receiving its proper rotary motion.

CHAPTER VIII.

CONCLUSION.

Recent important circulars from the War-Office—Appointment of adjutants by the Government to rifle corps—Conditions proposed—Formation of isolated companies into battalions, &c.

As these sheets were passing through the press, I received two important circulars, emanating from the War-Office, relative to the permanent organization of our Volunteers.

This, at least, is a step in the right direction, and will tend, more than anything that has yet been done, to give stability and permanence to the movement, and to confer upon the different corps scattered over the country, that solidity and efficiency which can only be derived from proper organization and discipline.

The absolute necessity for a proceeding of this kind I have all along strenuously pointed out, and though the plan, as at present put forth, is necessarily crude and capable of considerable improvement, we may receive it as an assurance that the authorities are at last in earnest, and are desirous of assisting those who are so nobly devoting their time and energies to place the country beyond the reach of foreign aggression.

The circulars alluded to, are addressed to the Lords-Lieutenant of the various counties. The Secretary-at-war commences by stating that, having had under consideration the expediency of the appointment of an adjutant, commissioned by Her Majesty, to every

brigade of artillery and battalion of Rifle Volunteers, he will be prepared to submit for the Queen's approval, the names of such officers as may be recommended by them, for the several corps serving in their counties, subject to the following qualifications and conditions of service:—1. That the candidate should have served at least four years either in the line, or in the army of the late East India Company, or in Her Majesty's Indian forces, or in the embodied militia. 2. That his application should be accompanied by testimonials as to conduct from his former commanding officer. 3. That the candidate shall be subject to an examination at the nearest garrison, as to his fitness to hold the office, and shall also have passed through a course of instruction in musketry at Hythe, or be prepared to do so when called upon. 4. The rank of an adjutant is properly that of a subaltern; but if appointed out of Her Majesty's regular forces, or Indian army, or the militia, he may retain the rank which he held in either of these services; but no adjutant shall be entitled, by virtue of his superior rank, to take the command of any company of Volunteers, an officer of the company being present, except for the purpose of instruction drill. 5. That, before receiving his commission, he shall transmit to the Secretary of State for War a declaration that no consideration has or will be made for such commission. 6. The pay of such adjutant shall be 8*s*. a-day, and 2*s*. to cover the forage for a horse, or for travelling expenses, provided the commanding officer has exempted him for the time being from the liability to keep a horse. Any other incidental expenses must be borne by the corps. 7. Such officer will not be allowed to follow any other profession, or hold any other appointment, public or private. The second circular has also been addressed by the Secretary-at-war to the Lords-Lieutenant on

the subject of forming the various scattered bodies constituting Volunteer rifle corps into battalions. It is proposed to adopt the following principles:—First, that a battalion of Volunteers may be formed either as a consolidated body, composed of various companies in densely populated districts, acting together as one corps, in the meaning of the Volunteer Act (44 George III., cap 54); or, secondly, it may be a consolidated body for drill and administrative purposes only, being composed of various companies forming in themselves distinct and (financially considered) independent corps; or, thirdly, a battalion may be formed, for administrative purposes only, from the various corps scattered over a rural or thinly populated district. In order, therefore, to meet these several forms of battalion organization it has been deemed desirable to lay down the following rules:—For a consolidated battalion, formed on either of the two first principles, 1 major and 1 adjutant will be allowed to 4 companies of min. strength; 1 lieut.-colonel and 1 adjutant will be allowed to 6 companies; 1 lieut.-colonel, 1 major, and 1 adjutant will be allowed to 8 ditto; 1 lieut.-colonel, 2 majors, and 1 adjutant will be allowed to 12 ditto. When the companies exceed 12, the corps will constitute a regiment, and be formed into 2 battalions, each with field officers and with adjutants in the above proportions; the whole to be commanded by the senior lieutenant-colonel. Although the Secretary-at-war is prepared to sanction the formation of a battalion of 4 companies, it is intended to provide only for cases in which no more than that number of companies can be formed in a town, and where it is not considered advisable to include any rural companies; and it should be understood that no two battalions of this strength, can be formed in one place. With regard to the third principle of formation, in-

tended to apply to rural districts, where the companies, &c., are greatly scattered, it is not intended that the formation into battalions should render the separate companies liable to be removed from their own neighbourhood, or to be brought together at any time when not called out for actual service, except with their own consent; or that the independent existence of the several corps should be in any degree affected; the object being, to accomplish one uniform system, in correspondence, drill, inspection, and returns, throughout the entire force. The following staff will therefore be allowed for rural battalions:—1 major and 1 adjutant to 4 or 5 companies of min. strength; 1 lieut.-colonel and 1 adjutant to 6, 7, 8, or 9 companies of min. strength; 1 lieut.-colonel, 1 major, and 1 adjutant to 10, 11, or 12 ditto. In effecting the formation of these battalions, it is recommended that the concentration of companies be considered with reference to locality, and not to their numerical standing in the *Army List*. Each company may continue to have its own rendezvous and drills, but it ought, besides, to have a battalion rendezvous established, as well as certain days set apart for battalion drills. The Secretary-at-War has not, he says, thought it desirable to insist upon a rigid adherence to uniformity in the clothing and equipment of corps serving in the same county, but he trusts that in any future renewal of the clothing, the propriety of adopting one general colour for companies belonging to the same battalion will be duly considered. It is to be hoped that those corps who had the ill-luck, in the first instance, to have foisted upon them, the uniform reported to have originated with the War-Office, may, at no distant time, be enabled to devise something, which partakes less of the livery of the lunatic and the pauper, and has some better claim to be adopted as a garb for

soldiers than its unbecoming appearance and the facility with which it shows every spot and stain.

I have now placed the reader in possession of all that it is requisite for him to understand and to keep in remembrance, while pursuing practically his education as a marksman. I will only add, that should he in addition be enabled to obtain the aid of a trained instructor, he will at once appreciate the advantages of having acquired a knowledge of the details comprised in the preceding pages; and even if he have no means of procuring that aid, or be prevented from visiting Hythe, and from undergoing the training there inculcated, he may, with moderate diligence, and by devoting not more than an hour-a-day for a few weeks, to aiming and position drill, become a first-class shot—without further assistance than that here provided.

In closing these observations, I cannot but express in the most unqualified terms, the high estimation I entertain, not only for General Hay and Colonel Wilford, but for all who are associated with them in the important duty of teaching the British Army "how to shoot."

To General Hay more especially is the gratitude of the nation due, for the noble institution he laboured so long and so arduously to establish, and which with Colonel Wilford's aid he has brought to its present high state of perfection.

In this instance, at least, the Department that appointed them, have happily made the best possible selection, and I sincerely trust, for the sake of the country, that the Inspector-General and the Assistant-Commandant, possessing as they eminently do the esteem, the confidence, and regard of all who know them, may long continue to hold the important posts, they at present occupy.

APPENDIX.

HYTHE PRACTICE, 1858—59.

From the last returns, the details of which are extremely interesting, it appears that the number of officers trained during the year at Hythe was 195 (which number includes 3 cavalry, 7 artillery, and 17 officers of Her Majesty's Indian forces), being an increase of 48 over the previous year; of these 195 officers, who were exercised in every respect as the non-commissioned officers and privates, 98 practised under the old system, and 97 (including the cavalry and artillery) under a new and somewhat simpler system. Of the former 75 (or 77½ per cent.) became first-class shots, and 21 (or 21¾ per cent.) second-class shots, leaving only 1 in the third class. Under the latter 52 (or 59¾ per cent.) became first-class shots, and 33 (or 38 per cent.) second-class shots, leaving only 2 in the third class.

From the return, in which the performances of the non-commissioned officers and privates under the old and new systems are detailed, it is observable that under the former 230 (or 60½ per cent.) passed into the first class, and 148 (or 39¾ per cent.) into the second class, leaving only 2 in the third class; and that under the latter 168 (or 52⅞ per cent.) passed into the first class, and 142 (or 44½ per cent.) into the second class, leaving 11 (or 3¼ per cent.) in the third class.

In the foregoing calculations the cavalry and artillery are not included, the men of these branches of the service being armed, the former with breech-loading, and the latter with rifled carbines.

The results of the performances of the officers, non-com-

missioned officers, and privates, in judging distances, were most satisfactory. Of the 195 officers, 131 (or 67 per cent.) passed into the first class; and of the 771 serjeants and rank and file, 529 (or 68½ per cent.) passed into the first class, leaving of officers only 2, and of non-commissioned officers and privates only 7 in the third class.

General Hay attributes the falling off in the per-centage of first class, in judging distance of the last 2 parties, not to any increased difficulty in passing from one class to another, but to the fact that an instrument has been used to determine the correct distance, instead of the chain formerly employed for this purpose, which circumstance now prevents the possibility of any collusion on the part of the men, by which their judgment could be assisted in arriving at the correct distance, thus the results in this exercise are rendered more trustworthy and the men more efficient.

The following table records the performances in those practices which are taken to establish the "figure of merit" of the shooting on the old system during the years 1857-8 and 1858-9 respectively; and also on the new system during the latter part of the year 1858-9 :—

OFFICERS.

Years.	First Period from 100 to 300 yards.	File and Volley Firing at 300 yards.	File Firing at 300 yards, standing.	Volley Firing at 400 yards, kneeling.	Skirmishing. First Practice.	Skirmishing. Second Practice.	Figure of Merit.	Per-centage of First-class Shots.
	20 Rnds.	10 Rnds.	10 Rnds.	10 Rnds.	10 Rnds.	10 Rnds.		
Old System.								
1857-8	18·71	9·13	...	...	5·51	3·73	37·18	64·62
1858-9	21·27	10 04	...	...	6·86	4·43	42·60	77·31
New System.								
1858-9	19·09	...	11·57	9·47	...	6·17	46·30	59·77
NON-COMMISSIONED OFFICERS AND PRIVATES.								
Old System.								
1857-8	17·80	10·64	...	...	5·22	4·11	37·77	59·48
1858-9	18·48	9·82	...	...	5 95	4·06	38·31	60·52
New System.								
1858-9	18·15	...	10·64	9·78	...	5.42	43·99	52·33

From the above table it is observable that there is a slight improvement in favour of the practices on the old system in 1858-9; but, if we contrast the performances on the new system with those on the old, the former will prove to be superior in the file and skirmishing practices, though otherwise slightly inferior. This, no doubt, is attributable to the fact that the practice up to 300 yards inclusive, was performed standing, instead of kneeling, after 200 yards. Shooting standing, up to at least 300 yards is, however, considered essential to efficiency, and will improve as the soldier becomes more perfect in the first practice of the present "position drill."

General Hay proceeds to state :—" Here I would draw attention to the results of the platoon firing, and observe that, from what I have witnessed, well-executed volley firing is almost as effective at 400 yards as file firing is at 300 yards.

" The several parties, after they have been exercised through the prescribed course, are practised in firing at 300 yards and 400 yards, without using the back sight.

" The following table records the results of the performances, which are most satisfactory .—

At 300 Yards.		
Number of Rounds Fired.	Number of Hits.	Hits per cent.
2000	1292	64 43
At 400 Yards.		
2066	1002	48·49

" The subjoined table will show the number of hits by ricochet, &c., during the past year, on the old and new systems, and the average points lost to each man by ricochet hits :—

System.	Classes and Distances at which they fire.		Per-centage of Hits, exclusive of Ricochets.	Per-centage of Hits, including Ricochets, to Rounds fired.	Per-centage of Ricochets to Total Hits.	Average Points lost on Account of Ricochet Hits.	Total Average Points per Man of each Class lost on Account of Ricochet Hits.
Old System.	3rd class.	100 Yds.	76·66	76·91	·36	·01	·31
		150 "	59·58	59·60	·46	·15	
		200 "	48 65	49·04	·80	·01	
		250 "	63·98	65·04	1·66	·06	
		300 "	54·38	56·51	3·50	·08	
	2nd class.	350 "	56·54	61·51	8·78	·15	1·70
		400 "	49·87	57·03	14·30	·23	
		450 "	44·87	52·84	17·77	·27	
		500 "	39·42	49·21	24·83	·31	
		550 "	38·00	48 05	26·47	·31	
		600 "	33·17	40·70	22·49	·43	
	1st class.	650 "	31 64	44·72	41·33	·50	2·12
		700 "	36·49	47·88	31·21	·41	
		750 "	23·71	34 39	45·04	·33	
		800 "	18·80	25·83	37·50	·23	
		850 "	16·51	26·18	58·44	·33	
		900 "	10·19	16·25	59·49	·82	
New System.	3rd. cl.	150 "	85·01	85·60	·70	·03	·24
		200 "	72·04	72·91	1·21	·04	
		250 "	59·03	60·32	2·34	·08	
		300 "	54·25	55·87	2·99	·09	
	2nd cl.	400 "	61·21	66·12	8·02	·26	1·49
		500 "	48 69	55·60	16·25	·44	
		550 "	38·16	46 47	21 78	·42	
		600 "	40 26	47·43	17·93	·37	
	1st. cl.	650 "	40·46	53·79	32·95	·69	2·14
		700 "	40·77	00·07	22·81	·50	
		800 "	24·34	32·40	32 70	·45	
		900 "	13 95	23·56	68·88	·50	

"In order to afford a fair standard of reference to guide instructors and others in estimating the merit of the performances at the several distances under the new system, firing singly in platoon and in skirmishing, the following table has been prepared, which, besides showing the greatest number of points obtained individually, records the per-centage of hits, and other data of interest:"—

Classes and distances at which they fire.		No. of Targets fired at.	No. of Rounds fired at each distance.	Greatest Number of Points obtained by an individual at the several distances. Officers.	Greatest Number of Points obtained by an individual at the several distances. Soldiers.	Greatest Numbers of Points obtained by an individual in the several classes. Officers.	Greatest Numbers of Points obtained by an individual in the several classes. Soldiers.	Greatest Average Points obtained by a single party in the several classess. Officers.	Greatest Average Points obtained by a single party in the several classess. Soldiers.	Average Points at the several distances established in each instance from every shot fired on the new system in the various practices and "periods" during the year
3rd class.	150 yds.	2	5	12	11	33	33	21·18	22·00	5·94
	200 "			9	10					4 80
	250 "			9	9					3·72
	300 "			8	9					3·25
2nd class.	400 "	4	5	6	8	20	23	14·76	16·00	3·44
	500 "			6	7					2·67
	550 "			5	6					2·09
	600 "			6	7					2·21
1st class.	650 "	6	5	5	7	15	16	7·96	11·00	2·31
	700 "			6	7					2·26
	800 "			3	4					1·30
	900 "			4	5					·75

File firing at 300 yards, standing (8 targets, 10 rounds), the average points, 10·74 ; volley firing, at 400 yards, kneeling (8 targets, 10 rounds), average points, 9·89 ; skirmishing, between 400 and 200 yards (1 target for each file, 10 rounds), average points, 5·46 ; battalion, "figure of merit," average points, 44·45.

In analyzing the foregoing table, it will be found that the greatest per-centage of hits, does not necessarily give the greatest average points ; while the former defines the quantity of hits, the latter affords evidence of the quality of the shooting.

The number of officers, non-commsisioned officers, and privates who obtained 7 points and upwards in the first class is recorded in the following table ; which also shows the per-centage to the number instructed, and the per-

centage to the number that practised, between 650 and 900 yards inclusive, under the old and new systems:—

OFFICERS.

System.	Number exercised.	Number practised in 1st Class.	Per-centage of Men who practised in 1st class to Number exercised.	Number of Marksmen.	Per-centage of Marksmen to Number practised in the 1st Class.
Old system	97	55	57	22	40
New system	87	33	31	18	54½
NON-COMMISSIONED OFFICERS AND PRIVATES.					
Old system	380	158	41½	48	30½
New system	221	116	36	57	49

This table shows, that although fewer men practised in the first class, under the new than under the old system, the per-centage of marksmen under the former, is greater than under the latter. This had been anticipated, the object having been to improve the shooting at the longer distances, as it was found that many men under the old system obtained just a sufficient number of points to pass into the first class, but could do little or nothing in shooting therein. Such men now expend the 20 rounds in the third period with far greater advantage in repeating the practices in the second class—viz., between 400 and 500 yards inclusive.

Of the 195 officers who underwent the course of training to qualify for the position of instructor of musketry during the year, 163 obtained certificates and 28 obtained second-class certificates; four failed, and consequently received no certificate.

RIFLE RANGES AND TARGETS.

A DESIGN for a rifle range has lately been issued from the topographical department of the War-Office, showing an arrangement which may perhaps be advantageously adopted in some localities.

The principal characteristic of the plan, is that originally suggested by me two years ago, in a former publication, and more recently, at page 29* of "*Rifle Volunteers, and How to Drill them*," where I recommend "the erection, across the practice-ground, of two or three light iron arches through which the shooters will necessarily have to aim."

In the lithographed description accompanying the above design, it is stated, that it "is frequently requisite to establish ranges for rifle practice in situations where any stray bullets would be a source of danger, and it therefore becomes essential that the range itself should be so secured as to prevent the possibility of any balls being projected beyond, or on either side of it.

"One method which has been recommended for the attainment of this object, consists in the erection of a butt fifty or sixty feet in height, and of proportionate width across one end of the range. As however the brickwork of which this is built, would suffer materially from the continued impact of the bullets, it is found necessary to face the front with iron plates, and the whole construction is thus rendered very costly, the estimated expense being in some instances upwards of 1500*l.*" An expenditure of 200*l.* or 250*l.* ought to be ample for the above purpose under any circumstances.

* 7th Edition.

"It is also evident, that as a considerable allowance must be made for lateral deviation of the bullets, the available space for placing Targets in front of the butt is considerably restricted, and a portion of the width of the ground is thus practically of no use.

"The diagram above alluded to, accordingly represents a range for rifle practice laid out so as to afford reasonable security to the vicinity, while at the same time the constructions required, are inexpensive as contrasted with the above estimate, and the whole of the ground is turned to full account.

The space delineated, is supposed to be 300 yards long by about 33 wide. It is so disposed as to afford 3 separate ranges, the longest being 298 yards, and the 2 other 190 and 90 yards, respectively. An earthen mound is thrown up across one end of the ground. This mound or butt is 100 feet long, 15 high, and 4 feet thick at the top. The sides are to have a slope of 2½ to 1, and to be revetted with turf. The ends are supported by brick walls about 2½ feet thick at the bottom, an exterior slope being given to their sides, of about 6 to 1.

"The materials for this butt, are to be obtained by excavating a ditch 7 ft. 6 in. deep, and 20 feet wide at the top in front of the butt. Where the soil is compact, sides and ends need not be revetted."

A pathway, 6 feet wide should be left between the foot of the butt and the edge of the ditch, the bottom of which should be slightly inclined, and provided with a drain, as it is intended to shelter markers during practice.

"For their accommodation, a recess is cut in the side of the ditch opposite to each target. This recess to be about 4 feet long and 4 wide, covered in at the top; and in damp or loose soil it may be lined with boards, the front being closed by a door furnished with a strong pane of glass. They are thus tolerably secure from the effects of the small splinters of lead, that invariably glance from the targets. An intermediate butt 50 ft. long is to be made about 100 yards from the first.

"Sheds may be erected at each of the firing-places. The

size and construction of these, varying with the uses to which they will be applied. In some instances—it is suggested that—buildings large enough for drill and exercise in bad weather may be requisite. The fronts of these sheds may be left open, or closed with vertical shutters.

"The rests for firing at the longest range are to be disposed, so as to command a view of three-fifths of the entire width of the butt at the farther end of the ground. In this space it is proposed to place three targets, and a similar number, at each of the two other ranges. Practice can be carried on at the whole of them simultaneously. A slight railing of wood, defines each of the nine stands for firing, and along the front of the stands, there is a bench 2 ft. 3 in. high and 4 ft. wide. A man, kneeling upon this to fire, will have his eye at the same height as when standing."

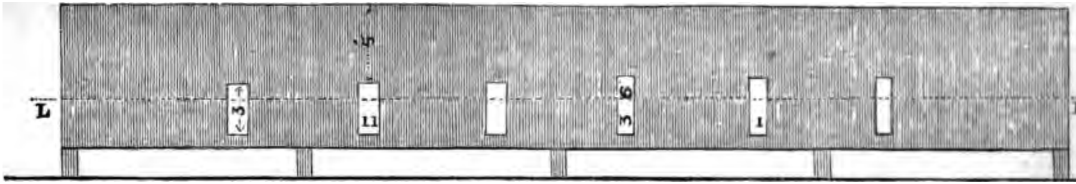
To prevent the bullets from passing over, or on either side of the butts, and also to ensure each man firing at the right target, the following arrangements are suggested :—

"At a distance of 15 yards from each firing station, a transverse screen made of hard wood 8 in. thick is constructed, the height of this is 11 ft., but as wood of this thickness is expensive, it is not necessary that the screen should be carried lower than 2½ ft. from the ground, and it may in that case be supported upon strong wooden posts." A frame of woodwork 2 in. thick, covered with sheet iron, will be found cheaper and in every way preferable, if inclined at an angle of about 5° or 6° *towards* the shooter.

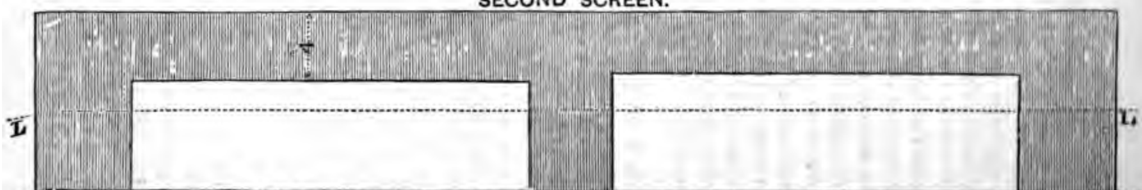
"In the screens rectangular openings are to be made to fire through. For the shortest range, these openings are 2 ft., and for the other two ranges they are respectively 16 in. and 1 ft. wide. It is presumed that they would give a sufficient lateral view on each side of the target without uncovering those adjacent.

"The height of the upper sills of these screens is to be so regulated for each range, that a bullet fired from a height of 5 ft. 3 in. from the ground, may be enabled to strike a point 2 ft. above the top of the target, without grazing the screen.

FIRST SCREEN.



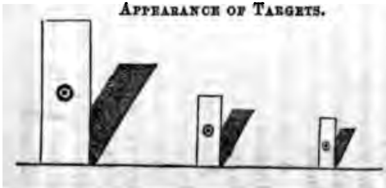
SECOND SCREEN.



LL Line adjoining the eye at 5 ft. 3 inches and the centres of targets.

SCREEN FOR 90 YARDS RANGE.

APPEARANCE OF TARGETS.



at 90, 190, and 298 yds. range.

LL Line joining eye and centres of targets.

"For the two longer ranges, a second screen is to be provided 30 yards in front of the first. This is also supported by strong posts, and its lower edge is to be of such a height, as to coincide with a trajectory, cutting the top sills of the first screen.

"It will be found that if a bullet fired from a height of 5 ft. 3 in., will strike 2 feet above the target at the 290 yard range, without grazing the upper sill of the screen, a bullet fired from a rifle resting upon the bottom sill of the windows of the shed, 4 ft. 6 in. from the ground, will be intercepted by the second screen, before it arrives within 2 ft. of the top of the butt.

"Should the soil be hard or flinty, to prevent any bullets that may strike the ground in front of the targets from glancing, it is suggested as a good safeguard, to throw up a series of traverses of earth, 2 ft. high; 30 yards apart across and at right angles to the range; any bullet striking one of these small embankments would at once be stopped.

"The details of the construction and arrangements adopted for rifle ranges must," it is added, "vary much according to the position of the ground, the nature of the soil, and the relative prices of the various materials required."

For instance, where there are no facilities for drainage, the markers could not well be stationed in the ditch, and ball-proof sentry boxes must then be provided to protect them.

A new system of constructing targets, which I have alluded to elsewhere, has recently been patented by Captain Chevalier.

He ingeniously connects, 3 or more comparfments on the surface of the target by means of an electric wire, with a small target close to the shooter, who is thus enabled at any range to note instantly the result of each shot.

The engraving on the opposite page represents the screens, and the appearance of the three targets as delineated in the diagram above adverted to.

The following estimate, given by Captain Petrie, (14th

Regiment, Topographical Staff,) showing the probable cost of providing such accommodation as that above described, may be useful as a guide in some localities, and where a corps is wealthy enough to expend from 650*l.* to 850*l.* on a practice range of only 300 yards.

BUTTS.

	£	*s.*	*d.*	£	*s.*	*d.*
Butt 100 feet long, 522 cubic yards of earth excavated, thrown up, and rammed, at 9*d.* per cubic yard	35	2	0			
Revetting 3102 square feet, at 9*d.* per square foot	64	12	6			
Retaining walls of brickwork, 900 cubic feet, at 9¾*d.* per cubic foot	36	11	3			
Excavating recesses for markers, 21 cubic yards	0	15	9			
150 square feet of boarding for markers' recesses	2	13	7			
Total				139	15	1
Butt 50 feet long, total cost				87	0	0

SCREENS.

	£	*s.*	*d.*	£	*s.*	*d.*
1st screen, 63 feet long, oak posts, braces, sills, &c..	21	15	4			
567 square feet of 4-inch oak, at 2*s.* . . .	57	14	0			
Facing of ½-inch iron, at 18*s.* per cwt. .	43	4	0			
Total				122	13	4
2nd screen, 67 feet long, oak posts, braces, sills, &c..	28	19	0			
387 square feet of 4-inch oak, at 2*s.* . . .	38	14	0			
Facing of ½-inch iron	30	12	0			
Total				98	5	0
Screen for 90-yard range, 37 feet long, oak posts, braces, sills, &c.	16	0	0			
370 square feet of 4-inch oak, at 2*s.* . . .	37	0	0			
Facing of ½-inch iron.	27	18	0			
Total				80	18	0

SHOOTING HOUSES.

	£	*s.*	*d.*	£	*s.*	*d.*
House 100 feet long by 20 wide and 7 high.						
Excavating foundations	8	11	2			
Brickwork for 9-inch walls with piers at intervals, at 10*l.* 10*s.* per rod . . .	105	0	0			
Carried forward	£113	11	2	528	11	5

	£	s.	d.	£	s.	d.
Brought forward . .	113	11	5	528	11	5
Roof, doors, &c.	88	4	0			
Painting, locks, hinges, &c.	2	0	0			
Total . .				203	15	5
House 30 feet in length, total cost				100	0	0
Shooting stands, railings, &c., for shooting-houses				18	0	0
Total cost of Rifle Range .				850	6	10
If the ends of the butts were sloped off similarly to the sides, instead of being supported by retaining walls of brick-work, the saving of expense would be	56	15	10			
As elm or beech can be purchased in many parts of the country for 1*s.* to 1*s.* 6*d.* per cubic foot; wood of this description might be used instead of oak faced with iron, and a saving on the screens might be effected of at least half their estimated cost	150	0	0			
Total saving . .				206	15	10
Leaving the expenses reduced to . .				£643	11	0

Glossary of some of the principal terms used in connection with the Science of Musketry.

ADJUSTMENT.—The act of regulating; thus, when a sight is set to a correct height it is said to be adjusted.

ANGLE.—The space contained between two lines that meet in a point. It may also be defined to be the point where two lines meet. Angles vary in size, but the size does not depend on the *length* of the lines which form it, but on their *direction* with regard to each other; thus, if a common rule, with a single hinge be opened, the two sides are said to form an angle with one another, and the more they are opened, the greater the angle will be, until at last the two sides of the rule form a straight line.

ANGLE OF ELEVATION, in musketry or gunnery, is the angle, which the axis of the piece makes with the plane upon which it rests.

ANGLE OF INCIDENCE.—The angle formed (at the point of contact) by the plane, in which a body is moving, with a line perpendicular to the plane.

ANGLE OF REFLECTION.—The angle formed by the line of direction of a body, rebounding from a plane, and a perpendicular line erected at the point of contact; the angle of incidence is, under all circumstances, equal to the angle of reflection.

ASSIGN.—To mark out; to assign a distance of 400 yards to any place, is to suppose that it is 400 yards to that place.

ATMOSPHERE.—The air that encompasses the earth on all sides.

ATTRACTION.—That fundamental law of nature whereby

every particle of matter has a tendency to be drawn towards another particle.

BODY.—A portion of matter limited in every direction.

CALIBRE.—The diameter of the bore of a gun. Calliper (calibre) compasses, are compasses with curved legs; they are used for taking the dimensions of ordnance, shot, shells, &c.

CIRCUMFERENCE.—The outside of a circle or ball.

CONTACT.—Touch; any two substances touching one another, are said to be in contact.

CONVEX.—Rising in a circular form, as the outside of a circle or curve.

CYLINDRICAL.—Long and round like a roller; that part of the bullet which is of this shape is said to be cylindrical.

DENSITY is proportionate to the contiguity of the particles of a body to each other.

DIAMETER.—The line drawn across a circle or ball from one side to the other, passing through the centre, and dividing it into two equal parts.

DILATING.—Widening, extending.

DIRECTION.—With regard to firing, this term is used in contra-distinction to *elevation*, and is taken to express the course which a bullet takes to the right or left; thus, if a bullet strike the ground short, but in the same line as the bull's-eye, the *direction* is said to be good, but the elevation insufficient; if, on the other hand, it hit the butt on the same level as the bull's-eye, but to the right of it, the elevation is said to be good, but the direction defective.

DIVERTED.—Turned aside, or drawn away from.

ELEVATION.—The angle formed between the line of sight and line of fire; this is sometimes called angle of sight; properly the elevation should be taken to imply the angle formed between the line of fire and the horizon called angle of fire, but it is often received in

the first-mentioned sense, the line of sight being usually horizontal when at target practice.

ELONGATED.—Lengthened, drawn out.

EMBRASURE.—An opening cut through a parapet, &c., in order to fire through.

EPAULMENT.—An embankment thrown up to cover or protect troops from the fire of an enemy.

ELASTICITY.—A body that yields to pressure, and recovers its figure again; hence air and gases are elastic bodies; lead and gutta-percha are non-elastic bodies.

EQUILIBRIUM.—Equality of weight, equipoise; bodies are said to be in equilibrium when they are equally balanced.

EXPANDED.—Spread, enlarged, dilated.

EXPERIMENT.—Trial, proof.

EXPLOSION.—The act of driving out with force and violence.

EXCESS.—That which is over and above; excess of windage is that which is too much.

FRICTION is that retarding influence caused by the irregularities of the surfaces which act one upon another.

FORCE.—Any cause which produces, or tends to produce, a change in the state of rest or of motion of a particle of matter.

FORCES are measured by comparison with weights. Thus any forces which will bend a spring into the same positions as weights of 1 lb., 2 lb., 3 lb., &c., are called respectively forces of 1 lb., 2 lb., 3 lb., &c., &c.

FULCRUM.—A prop or support upon which a lever or hand-spike is supported when applied to raise any weight.

GROOVE.—Furrow, indentation.

HORIZONTAL.—Level; the surface of smooth water is horizontal.

IMPETUS.—The force with which any body moves towards a point, or strikes any other body.

INCLINATION.—Leaning, bending; a sight is said to be

inclined if it is not perfectly upright when held at the "Present."

INERTIA.—That passive property of matter which causes all bodies to resist, in a state of rest or motion, and which causes them to receive motion in proportion to the force impressed upon them.

LEVER.—A rigid bar moving upon a fulcrum or prop, and ordinarily used for raising weights, or overcoming greater resistance than could be effected by the natural strength without it. Levers are of three kinds; 1st, where the fulcrum is between the weight and the power; 2nd, where the weight is between the power and the fulcrum; 3rd, where the power is between the weight and the fulcrum.

MASS.—The quantity of matter in any body.

MOMENTUM.—The quantity of motion in a moving body. It is the product of its mass or weight multiplied by its velocity. If a body moving at first with a certain velocity be afterwards observed to move with double or treble this velocity, the quantity of motion of the body is conceived to be doubled or tripled; hence the momentum of a body depends upon its velocity; in the same way that the amount of motion of a body is measured by the product of the velocity, by the mass.

The elementary principles upon which all our calculations respecting the motions of bodies are based, are called the "Laws of Motion," and as arranged by Sir Isaac Newton, are three in number:—

1st. A particle at rest, will continue for ever at rest, and a particle in motion will continue in motion uniformly forward in a straight line, until it be acted upon by some extraneous force.

2nd. When any force acts upon a body in motion, the change of motion which it produces, is proportional to the force impressed, and in the direction of that force.

3rd. Action and re-action are equal, and in contrary directions. In all cases the quantity of motion gained

by one body is always equal to that lost by the other in the same direction.

Thus, if a ball in motion strike another at rest, the motion communicated to the latter, will be taken from the former, and the velocity of the former, will be proportionately diminished.

Centre of gravity is that point at which the whole weight of the body may be considered to act, and about which, consequently, the body when subjected to the force of gravity only, will balance in all positions.

MOTION.—The change of local position; opposed to a state of rest; there are three general laws of motion :—

1. A moving body always preserves an uniform motion in a right line, till it encounters some external force.

2. The change of motion is produced in the right line in which that force acts, and is proportionate to the force employed.

3. When one body acts mechanically upon another, the latter exerts an equal force in a contrary direction on the former body.

MUSKETRY.—All that relates to the construction or employment of the rifle or musket, and instruction in its use. The school of musketry, implies a school at which everything relating to the musket or rifle is taught.

PRODUCE.—When a line is lengthened in the same direction, it is said to be produced.

PARTICLE, or material point, is a body of evanescent magnitude. Bodies of finite magnitude are said to be made up of an indefinite number of particles, or material points.

PIVOT.—The pin, shaft, or part upon which a body revolves.

PLANE (inclined).—A sloping surface, or one that makes an angle with the horizon.

PLUMMET.—A leaden ball or bob, suspended to the end of a line, used to test the perpendicularity of objects.

PURCHASE.—A mechanical power and its effect; to take

a purchase, is to place a lever in such a position relative to the body to be moved, as to be prepared for heaving with effect.

Revetment.—The masonry which retains the earth of the rampart in its place.

Screw.—A cylinder with a spiral groove or channel cut in a spiral direction round it, in such a manner that the inclination may be the same throughout its whole length. The spiral projection is called the "thread," and sometimes the "land," the furrow is also termed the groove. The internal screw is called a *female* screw, one that works therein, is termed the *male* screw.

Pointing Rods or Pickets.—Two iron rods planted on the parapet of a mortar battery in the alignment of the axis of the mortar and the object to be fired at.

Specific Gravity.—The weight belonging to an equal bulk of every different substance. It is estimated by the quantities of matter, when the bulks are the same; or, in other words, it is the density that constitutes the specific gravity. Pure distilled rain water is assumed as the standard to which the comparative weights of all other bodies are referred. Lead is about eleven times the weight of the same bulk of water.

Standard of Specific Gravity.—The *imperial pound avoirdupois*, the standard unit by means of which all heavy goods are weighed, is *defined* to be the weight of *one-tenth* part of an imperial gallon, or of 27·7274 cubic inches of distilled water, ascertained at a time when the barometer stands at 30° and *Fahrenheit's* thermometer at 62°; and this standard may consequently be verified or recovered at any time.

If the weight of a cubic inch of distilled water be divided into 505 equal parts, and each of such parts be defined to be a *half grain*, it follows that 27·7274 cubic inches contain very nearly 7000 such grains; and it is hence declared by Act of Parliament, that 7000 *grains* exactly, shall be considered as the *pound* avoir-

dupois: and that 10 *grains* shall be equivalent to 1 *scruple*: and 3 *scruples* to 1 *drachm*: but these latter denominations are seldom necessary unless great nicety be required.

The *Restored Imperial Standard Pound Avoirdupois* is constructed of platinum, its form being that of a *cylinder* nearly 1·35 inch in height, and 1·15 inch in diameter, marked P.S., 1844, 1 lb.

VELOCITY is the *rate* of motion; there are four rates of motion—viz., Uniform, Variable, Accelerated, and Retarded.

1st. Uniform—when a particle traverses equal distances in any equal successive portion of time.

2nd. Variable—when the spaces passed over in equal times are unequal.

3rd. Accelerated—when the distances traversed in equal times, are successively greater and greater.

4th. Retarded—when the distances traversed in equal times are successively less and less. Acceleration or retardation may also be equal or unequal—that is, uniform or variable in use; 1200 feet per second is assumed as the initial velocity.

Angular Velocity is the velocity with which the circular arc is described, and depends upon the perpendicular distance of the point from the axis of rotation.

Terminal Velocity may be thus illustrated:—If a cannon-ball were allowed to drop from a very great height, it would, by the law of gravitation, descend with accelerated motion towards the earth, but as the resistance of the air increases as the squares of the velocities, a point would be reached, when the resistance would be equal to the force of gravity, from which point it would fall to the earth at an uniform rate during each subsequent second.

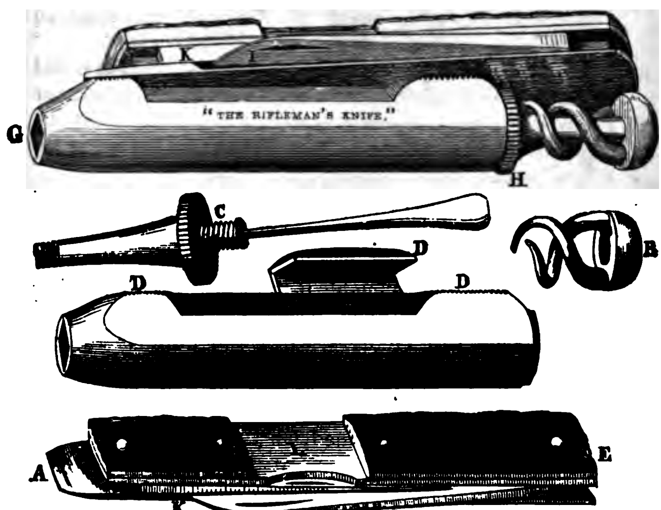
Initial Velocity of a bullet is the velocity it possesses as it quits the muzzle of a gun.

VOLUME.—The space bounded by the exterior surface of a body is its apparent volume or size.

THE RIFLEMAN'S KNIFE.

(Registered.)

The knife, of which an engraving and description are subjoined, having been much approved of by those who have practically proved its utility, Messrs. Holtzapffel (64, Charing Cross, London) have undertaken to manufacture it for the use of riflemen generally, and at the lowest remunerative rate.



The excellence of their workmanship is so well known that it needs no comment. This knife comprises, as will

be seen, every instrument that can ordinarily be required in connexion with the rifle.

By means of the instruments here combined, every part of the lock and furniture can be taken to pieces, cleaned, oiled, and replaced. A bullet can be drawn, the barrel can be thoroughly cleaned, and the nipple can be taken out, should any temporary obstruction necessitate its removal.

The upper figure represents the knife in a compact form, as intended to be carried in the pocket or cartouche box. The four lower figures show the different parts detached.

A, is a strong steel turnscrew, sufficiently powerful to remove all the screws from the regulation rifle.

B, is a powerful steel worm, adapted either for drawing a bullet, or to assist in cleaning the barrel. It screws on to the end of the regulation ramrod.

C, Drift for oiling the lock, &c. This screws into the oil-bottle H, *from right to left.*

D, D, D, Cramp for securing the mainspring.

E, Picker.

G, Nipple-wrench.

H, Oil-bottle. This will contain a supply of oil for the lock, sufficient for several months' use. (The oil used should be either clarified neat's-foot or petroleum oil.)

I, Large blade of knife.

K, Small do.

L, Socket in knife to enable it to fit into the mainspring cramp D, D, D.

Either blade can be used when the knife is in that position, so that it is equally serviceable, when detached from the cramp or not.

THE END.